THE UNITED STATES DISTRICT COURT FOR THE
NORTHERN DISTRICT OF OKLAHOMA

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Plaintiff,

vs. 4:05-CV-00329-TCK-SAJ

TYSON FOODS, INC., et al,

Defendants.

- -

MOTION FOR
PRELIMINARY INJUNCTION HEARING

BEFORE THE HONORABLE GREGORY FRIZZELL

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I N D E X

to date and you said you had no idea?
A I did not at that time, that's correct.
Q And I asked you then to tell your lawyer, Mr. Page, so he could tell me. We asked him again last Saturday for that information. We still don't have it. How much have you charged to date, sir? **04:50PM**
A I believe the number is about $400,000 over three and a half years.
Q In your lines of evidence, you talked about your review of technical literature? **04:50PM**
A Yes, sir.
Q Which led you to the conclusion that there's a high concentration of E. coli, Salmonella and Campylobacter in poultry waste?
A In poultry operations and poultry waste. 04:50PM
Q In poultry operations and in poultry waste. Well, we know, for example, that one of the reasons that we want to thoroughly cook chicken is because of the possibility of Salmonella; right?
A Yes, sir. 04:50PM
Q Chicken can either come to your kitchen with Salmonella or it can acquire it when it's in your kitchen on the countertop; is that right?
A I suppose it can. I don't believe that's the most likely situation. 04:51PM

Q Every warm-blooded mammal is a reservoir of E. coli; is that right?
A I would say that's true, yes, sir.
Q Each one of us here -- all but one of us here in the courtroom would be considered a reservoir for E. coli? **04:51PM**
A I certainly am. I can't speak for anyone else.
Q Well, as a toxicologist, you know that to be so, don't you, sir? **04:51PM**
A Yes, sir, and that's why we do contribution analyses to sort through these kinds of issues.
Q And cows are a big producer of E. coli, aren't they?
A Can be in certain circumstances. 04:51PM
Q Various kinds. In fact, don't they produce some of the most hazardous kinds of E. coli on occasion?
A Can.
Q And the fact that you find E. coli in the watershed really just tells you you have E. coli in the watershed; isn't that right? **04:51PM**
A If that was the only question that you've asked, it would tell you only that.
Q That's the one I'm asking now. **04:52PM**

A But that's not where I stopped.
Q And the fact that you found Campylobacter in the watershed would tell you something was a source of Campylobacter in the watershed; is that right?
A If you found it there, you would, but the fact that you don't find it there is not an indication that it is not present. 04:52PM
Q Now, I want to visit with you about that for a minute. You talked about the indicator bacteria, and the indicator bacteria enable you to say that something is there that you can't find, that you can't see, that you can't culture? **04:52PM**
A Yes, sir, there are good occasions of that.
Q You're asking the judge to assume something is there which you you can't find, which hasn't been proven to be there, but because something else is there, it might be there; am I saying about what you are saying? **04:52PM**
A I would not have said it that way, no.
Q Let me ask it another way. How many times did you look for Campylobacter and Salmonella in the watershed? **04:52PM**
A In the early stages we looked for it frequently.
Q Where did you look? **04:53PM**

A We looked in the environmental samples that were collected.
Q I mean, what kinds of samples did you look in?
A I believe that it was looked for in litter. It was looked for in water, and it was looked for in edge of field samples. I'd have to look back to see if it was further than that. 04:53PM
Q Why did you stop looking?
A I'm not sure what the reason for stopping looking was. I know after about six or eight months we didn't sample for it any longer. We identify -- 04:53PM
Q You didn't find any?
A None was found, and we identified the fact that it's well-described in literature that not only Campylobacter, but E. coli and Salmonella are specifically identified as species for which you can have them present and not be able to culture them. 04:53PM
Q Well, let me hand you a demonstrative exhibit which I've never seen before in my life.
A That's kind of a risky move, isn't it? 04:54PM
MR. TUCKER: I'm not going to hand it to him, Judge.
Q Did you look for it in dust?
A In dust?
Q Yes. **04:54PM**

fate and transport opinion; correct?
A I am offering an opinion about how it got there and I'm offering it for two reasons. One, the bacteria levels are very high and second of all, the signature that was identified is of cattle, is of poultry. 09:43AM
Q You're relying upon the work of Dr. Roger Olsen for your belief that the water shows the evidence of poultry contamination; correct?
A In part I am, and I'm also relying on that of Dr. Harwood and the other lines of evidence that I described yesterday. 09:43AM
Q You yourself, sir, have you conducted no fate and transport analysis; correct?
A No, I did not, not formal. 09:44AM
Q Based upon the work you have done in this case, not the work of others, can you state to a reasonable degree of scientific certainty that if Judge Frizzell grants the injunction that is requested by your client, the water quality standards for bacteria in the Illinois River will be met in 2008 and 2009? **09:44AM**
A My opinion is they will be.
Q Can you state that opinion to a reasonable degree of scientific certainty? **09:44AM**

A I can based on the --
Q You're willing to stake your professional reputation on the proposition if this court enters the injunction sought by your client the water quality standards for bacteria in the Illinois River will be met next year? **09:44AM**
A Based on all the information I have and my knowledge of microbial growth in the environment, I believe that to be the case.
Q You're willing to stake your professional reputation on it? **09:44AM**
A I don't know what you mean.
Q If you offer an opinion and that opinion is incorrect, perhaps your reputation has been jeopardized. Do you have the confidence in the opinion that you just expressed that you're willing to stake your professional reputation on it? **09:45AM**
A Sir, if I didn't think that was the case, I wouldn't be here.
Q Okay. Now, sir, you've done no analysis to quantify the relative sources to a water body; correct? **09:45AM**
A I think this is about the same question you asked me a moment ago and we looked at loading and we looked at sources in the water bodies of what the 09:45AM

bacteria were.
Q You conducted no fate and transport analysis to see which of those sources actually impacts the water body more substantially; correct?
A I think I've answered that. I think that we have done it. 09:45AM
Q Have you done that?
A I have reviewed information that the team has provided that answers that question for me.
THE COURT: I think we've answered that question. 09:45AM
MR. GEORGE: He's not going to -- I want to make sure someone doesn't get up later, Your Honor, and say Dr. Teaf conducted the fate and transport analysis here. 09:45AM
THE COURT: I think we've plowed that ground.
MR. GEORGE: I'll pass the witness, Your Honor.
REDIRECT EXAMINATION
BY MR. BULLOCK:
Q Just a few things. Dr. Teaf, yesterday Mr. Tucker presented some information concerning TMDLs in various watersheds, for instance the South Canadian? **09:46AM**

A Yes, sir.
Q What does the information discovered in producing the TMDL for the South Canadian River tell you about sources of pollution in the Illinois River watershed? **09:46AM**
A Tells you absolutely nothing and it would be dangerous to make assumptions between watersheds.
Q Okay. Now, a great deal has been made about the issue of finding Campylobacter or Salmonella. Is it not -- can you not culture those organisms so you can count them? **09:46AM**
A Under certain circumstances it's possible to do so but both of those organisms and E. coli as well are well-known to be stressed in the environment to the point that they are not culturable. They're not able to be tested in a lab or grown up in the lab, but they're perfectly infective, the bacteria are alive and well so it's an interesting problem. It's been identified in the literature many times and it's a real public health problem because you can find illnesses and you can know that the bacteria are present in the water, but you can't find the bacteria in the water because of it's viable, but not a culturable state. 09:47AM
Q Now, also yesterday there was examination **09:47AM**

directly as to depth. The limitation -- that would be the length of your ability to push. The depth of penetration would be the point of refusal, which would be the intercepting rock that's competent enough to no longer permit the geoprobe to advance by hydraulic pushing. 01:39PM

Q You reviewed the geoprobe work and data in this case; is that correct?

A I've looked at that data, yes.

Q Sir, can you give us the typical range at which water was collected using the geoprobe device? 01:40PM

A Shallow.

Q Define that, please.

A Okay. Probably less than 20 feet in most cases. 01:40PM

Q Sir, what is the average depths of the shallow wells -- you used that term in your affidavit -- in northeast Oklahoma that are being used by residents for consumption of drinking water?

A Well, the criteria for looking at shallow wells, I don't know what the average depth of shallow wells is, but the wells that were selected for sampling would be those that would be largely completed within the Boone and/or the underlying Saint Joe, so around 150 total depth. 01:40PM

Q Sir, are you aware of a single well in northeast Oklahoma that is completed to a depth of less than 20 feet?

A I am not personally aware. That would in all likelihood be a dug well and be quite old. 01:40PM

Q People in northeastern Oklahoma are not relying upon wells that are completed to a depth of 25 to 30 feet, are they, for drinking water?

A Typically not.

Q You agree with me, do you not, sir, that samples collected through the State's geoprobe process are not representative of water actually being consumed by northeast Oklahomans? 01:41PM

A One would hope they are not representative of water being consistently consumed by people in northeast Oklahoma. 01:41PM

Q Do you recall getting that same question in your deposition?

A No, I don't, but I'm sure you can play the tape. 01:41PM

Q Let's go to Page 129, Lines 19 through 23.

(Whereupon, an excerpt of the videotaped deposition of Berton Fisher, PhD was played.)

Q "Is it your testimony, sir, in this case that the values reflected in geoprobe sampling are 01:41PM

reflective of what northeast Oklahomans are actually consuming from their residential wells?

A No".

Q You haven't changed your position on that, have you, sir? 01:42PM

A No.

Q Sir, you are a geologist; correct?

A That's correct.

Q You worked on, as I heard your description of experience, groundwater cases involving petrochemical and petroleum products; correct? 01:42PM

A Yes, and salt.

Q Sir, prior to being retained by the attorneys representing the attorney general's office in this case, had you ever worked on another case in which the constituent of concern was bacteria? 01:42PM

A Yes.

Q Do you recall getting that question in your deposition?

A Yeah, I did, and I need to amend that because -- 01:42PM

Q Let's look at what you said, and we'll give you a chance to amend. Will you play a clip beginning on Page 11, Lines 13 through 16?.

(Whereupon, an excerpt of the videotaped deposition of Berton Fisher, PhD was played.)

Q "Sir, can you identify for me the cases that you've worked on in litigated matters where the constituent of concern was bacteria? 01:43PM

A There are no such cases."

Q Sir, is it your testimony today that there are such cases?

A Yes, there is, and the reason that I didn't recall at the time, Wise County cases involved bacterial growth producing hydrogen sulfide in residential wells as a consequence of the introduction of natural gas and condensate. So I didn't think about that it was coming from the surface, but the contaminants of concern was hydrogen sulfide. 01:43PM

Q You were not asked to address the fate and transport of bacteria found in groundwater, were you?

A No. 01:44PM

Q You are simply evaluating the effects of bacteria found in certain wells?

A That's correct.

Q So as it stands today, sir, you have never before worked on a litigated matter in which you 01:44PM

computer code to create a representation of how water behaves in the environment, so how -- there may be rainfall, how that may interact with the ground surface, some of that potentially moving into the groundwater, some of that potentially running off and carrying materials with it. 03:33PM

Q You agree there are some pretty sophisticated computer models out there that can be used to evaluate the likelihood and relative contribution of various sources impacting water in a watershed? 03:33PM

A Certainly.

Q Have you conducted a water quality model or fate and transport model, sir, in order to evaluate the extent to which the land application events that you have identified would be likely to affect the Illinois River or its tributaries? 03:34PM

A Not for bacteria.

Q You worked on that for other constituents?

A For other constituents.

Q But you haven't performed that analysis with respect to bacteria? 03:34PM

A Not for bacteria.

Q Were you asked to perform that for bacteria?

A I was not.

Q Now, these hydrologic models that you're using on some other part of the case and you worked with in the past, they're commonly used in the formulation of TMDL's, are they not? 03:34PM

A Many of them are used for TMDL purposes.

Q Sir, you have experience, do you not, sir, in working with regulatory bodies in evaluating source contribution through models and other devices to fashion TMDL's or draft TMDL's? 03:34PM

A I have, yes.

Q Sir, you will agree with me as someone who has expertise in fate and transport that there are a host of site specific factors that will control whether bacteria from a particular poultry litter application or any other potential surface source can be reasonably expected to make it to the Illinois River watershed or Lake Tenkiller? 03:35PM

A Yes.

Q Some of those factors would include what, site specific factors?

A The site specific factors may include soils, may include location with streams or other features of interest, may include topography, may include application of waste, amount of waste, content of that waste. So those would be some of the more important factors. 03:35PM

Q And each of those factors in a system with the diversity of the Illinois River watershed would vary from land application site to land application site; correct?

A They would certainly have the potential to. 03:36PM

Q Sir, have you conducted any analysis to determine whether any particular land application site identified by you in your work in this case has, in fact, contributed to the bacteria levels found in the Illinois River, its tributaries or Lake Tenkiller? 03:36PM

A I have not conducted such an analysis.

Q Are you familiar with the terms hotspots?

A Yes.

Q What does that term mean in the context of watershed planning? 03:36PM

A Certainly. So the discussion we just had about how site specific kinds of factors may influence the potential movement of water and constituents that it may carry varies. Those locations that would tend to have combinations of these factors that would contribute substantial and disproportionate amounts of contaminants might be termed hotspots, and there would be other terms as well. 03:36PM 03:37PM

Q Sir, are you aware of the fact that the EPA has encouraged regulators to not make generalizations about source categories but -- in their regulatory programs, but to focus on the hotspots trying to control and improve water quality? 03:37PM

A That's an approach that's commonly used, yes.

Q Sir, you've spent a good bit of time today discussing the amount of poultry litter generated in the watershed. Have you evaluated the magnitude of any other source of bacteria in the watershed? 03:37PM

A Well, with poultry litter I didn't evaluate the amount of bacteria for poultry litter, and, you know, I did some quick back of the envelope calculations based on some materials that Dr. Clay provided to try and understand the approach he was using and how he arrived at bacteria, but that was the extent of any bacteria calculations. 03:38PM

Q Sir, you have been involved, have you not, sir, in the past in studies that have found the urbanization of a watershed have increased the level of bacteria in surface water? 03:38PM

A Yes. Urbanization and, therefore, the sources of contamination that go with it have the potential to do just that. 03:38PM

tracking as a reliable method of tracking fecal bacteria in the environment?
A Yes. As I said, they have several experts working on this area themselves.
Q Dr. Harwood, I'd like to call your attention to State's Exhibit 59-1. It should be in front of you there on the lectern in front of you. 11:22AM
A Yes.
Q Would you please identify that for the Record?
A Yes. That's my CV. 11:22AM
Q Is it a current copy of your curriculum vitae?
A Yes, it looks like it.
Q Have you recently updated that curriculum?
A Yes. Just recently we had a paper that's been published in applied environmental microbiology in 11:23AM quantitative PCR so that was an updated edition.
Q You said quantitative PCR?
A Quantitative polymerase chain reaction.
Q So PCR stands for?
A Polymerase chain reaction. 11:23AM
Q I'll let you say that all day. I'll say PCR.
A Okay. Me, too.
Q When did you first become involved in the cases before the court here today?
A I was first contacted in August 2004 and then 11:23AM

did not start working on the case until April 2005.
Q What is your understanding, Doctor, about the subject matter of the case that's before the court today?
A The Oklahoma Attorney General has filed suit 11:23AM against some poultry integrators in order to stop or place a moratorium upon land application of poultry litter due to environmental, ecological and human health hazards associated with that practice.
Q Were you given any assignments in this case? **11:24AM**
A I was asked to help plan sampling procedures, review analytical results for microbiology analyses and render opinions on the -- on aspects of microbiological water contamination from land applied poultry litter and human health risks that 11:24AM could result from that practice and also worked in conjunction with North Wind Laboratory to develop what we term a poultry litter biomarker, a specific PCR assay for bacteria that are associated with poultry litter to use as a tracer for land applied 11:24AM poultry litter.
Q Okay, Doctor. Doctor, what materials have you reviewed in order to accomplish those assignments?
A I've reviewed a lot of documents, but they include results of microbial testing that were sent 11:25AM

to me by CDM, and the analyses were done by laboratories, three laboratories, FoodProtech, A & L Laboratory and EML Laboratory. I reviewed documents from the State of Oklahoma and from the USGS about water quality in the IRW. I reviewed affidavits of 11:25AM experts in the case including Dr. Teaf, Caneday, Olsen, Engel, Fisher, Lawrence to name some of the ones I can remember off the top of my head, numerous peer reviewed articles in the literature.
Q Have you also reviewed any environmental or health assessment data with regard to bacteria in preparation for your opinions? **11:25AM**
A Yes. Reviewed standards for the State of Oklahoma and for the US EPA and again numerous peer reviewed articles on the subject. 11:26AM
Q In particular for your evaluation in this case, what water quality standards have you evaluated?
A I have evaluated the State of Oklahoma's recreational water quality standards and US EPA's 11:26AM recreational water quality standards.
Q Do you know how those standards are set?
A Yes, those standards are set based on epidemiological studies, and so in those studies, one measures the rate of disease, and usually most 11:26AM

generally gastroenteritis is the most commonly measured disease syndrome. One measures the rate of disease in exposed individuals, so people who are in the water would be exposed individuals, compares that to individuals, the rate of disease in 11:27AM individuals who are not exposed and also at the same time measures other parameters such as indicator bacteria concentrations to determine what the correlations might be between illness rates of those who are exposed to the water and potential 11:27AM correlated factors, again, like fecal indicator bacteria concentrations.
Q So those standards are based on indicator bacteria?
A Those standards are based on indicator 11:27AM bacteria concentrations, yes.
Q Now, are fecal indicator bacteria an important aspect of evaluating water quality?
A Yes. Fecal indicator bacteria are relied on throughout the world as indicators of water quality. 11:27AM
Q Okay. Is there any other reason why fecal bacteria would be important as a measure or test of water quality evaluations?
A Well, they are really important because they do have a correlation with the risk of human health 11:28AM

when recreating in water bodies.
Q Is it possible to test for all potential pathogens in water?
A It is really impossible to test for all potential pathogens. There are so many possible organisms that can cause waterborne disease the expense, the time, the logistics of doing such analyses have always proven to be beyond what we can do in science.
Q Then do the fecal indicator bacteria, do they act as a sort of surrogate for all the other pathogens? 11:28AM
A Yes. We use the fecal indicator bacteria as a tracer or a surrogate to indicate the risk of the presence of human pathogens and thus, the increased risk to human health from exposure to that water. 11:28AM
Q Now, is it true that some pathogens that are in fecal material can be alive but not be culturable?
A That's correct. The -- I guess the century old methodology for measuring bacterial concentrations is to culture them on some sort of an auger medium. We've known in the last 20 years or so that many organisms when they're excreted from their host and they get out into the environment may 11:29AM

not die off, but they may become -- they may die off, but they may also become stressed, physiologically stressed in which case they can no longer grow on the media we normally use to culture them or detect them, and so many studies have shown 11:30AM when these bacteria become viable, we call this the viable but non-culturable phenomenon. They still have indications of metabolism and of the ability to sustain themselves. They can also be resuscitated or revised and start growing again when they get 11:30AM into to a host so when they get back into an environment that is conducive to their growth. So in spite of the fact that we cannot culture them and detect them, they are still potentially dangerous, and this is known in microbiology as the viable, but 11:30AM not culturable phenomenon. It's been seen in pathogens such as Salmonella and Campylobacter.
THE COURT: I take it viability depends on a number of factors, temperature, other environmental factors. Give me an idea of what 11:30AM those major factors are and the time frame within which viability exists.
A Okay. In microbiology there's almost never a real simple answer, so I'm sorry about that. It depends on -- 11:31AM

THE COURT: I'm afraid that's usually the case in the law, too.
A Good. You all understand. Depending on what type of bacteria one is talking about, they can be -- we might say inactivated. So inactivated or 11:31AM killed by factors such as ultraviolet radiation is a potent one. Many bacteria are very susceptible to high salt levels or other high osmotic pressure levels. There is generally in the environment cooler temperatures are more conducive to long-term 11:31AM dormant survival. However, in warmer waters, there's also evidence that bacteria -- that *gut bacteria, Enterobacter, given some sort of carbon source to grow on, that they can actually survive and grow in sediments of or at least retain 11:32AM viability long term in the sediments of water bodies, and the nutrient availability is one of the primary factors that will inactivate microorganisms when they are released into the environment. Desiccation also plays a role, so drying out. 11:32AM Again, it's very hard to say. It depends on a lot of common conditions that the bacteria encounter. If they are exposed fully to ultraviolet radiation and desiccated, it may take only a matter of hours for them to be permanently inactivated or killed. 11:32AM

On the other hand, if they're shielded from radiation, if they're provided with some moisture, they may persist for up to months at a time.
THE COURT: Thank you. Mr. Page.
Q So those bacteria can remain viable for months at a time if they have certain environmental conditions available? 11:33AM
A That's correct.
Q At the same time, if you use a standard method to try to identify that bacteria in the environment, it wouldn't necessarily be culturable? 11:33AM
A That's correct, because the bacteria may be surviving and persisting in the environment, but they may be stressed to the point where they won't grow on this basically artificial substrate that 11:33AM we're providing them.
Q Now, if a pathogen such as Campylobacter goes into this viable but not culturable state, can it then also remain as a hazard to human health?
A Yes, that is for sure in that viable but not 11:33AM culturable organisms, when passed into a host such as perhaps they were ingested in water can resuscitate, start growing again and cause an infection.
Q Dr. Harwood, in response to the court's 11:34AM

grow or not and requires that one use the correct medium, that one has the correct incubation temperature. So culture based methodologies are fraught with difficulties of interpretation. PCR based methods are basically being able to detect a specific genetic component of the bacterium. We use DNA -- we use the PCR over a DNA Xeroxing machine. It's highly specific. It can amplify or produce large amounts of DNA from small amounts. It's rapid, and it doesn't depend on the physiological state of the organism for detection, and again, it's actually much more highly specific than culture based methods for bacterial identification R. 11:51AM 11:51AM

Q Is PCR considered by the scientific community to be a reliable method to detect specific bacteria? **11:52AM**

A Yes. In other scenarios other than bacterial uses, identification of bacteria as well. So it's used, for example, in the legal field to determine the guilt of criminals or to free innocent people. It's also used in the medical setting to, again, to -- this goes back to the bacterial component -- to identify bacteria, viruses and other infectious microorganisms that cause disease. It's very widely used in the forensic and the clinical communities, and it's making major inroads into environmental 11:52AM 11:53AM

microbiology as well.

Q So is your testimony that the PCR method that you employed in this case is the same methodology that's used to look at DNA in the criminal context to determine whether someone's DNA is in a crime scene or something like that? **11:53AM**

A It is essentially the same type of methodology.

Q Is it the same methodology they use in hospitals to identify the source of a disease? **11:53AM**

A Yes, essentially the same.

Q Okay. Now, Doctor, are you aware of a standard conventional method of detecting poultry bacteria in environmental media?

A There is no standard conventional method for specifically detecting poultry contamination in environmental waters. 11:53AM

Q So when you are faced with a hypothesis as an environmental question like this, how do you go about answering the question of such hypothesis? **11:54AM**

A That's one of the things my laboratory specializes in, is developing methodology that can be validated in controlled settings and then used in the field to answer questions about where microorganisms come from in waters. 11:54AM

Q Is that what you did when you developed the PCR methodology in this case?

A Yes, it is.

Q Doctor, I want to call your attention to State's Exhibit 435, and, again, there's a copy in the packet in front of you, but there's also a blow-up of the exhibit on the tripod. Would you identify this document for the Record, please? **11:54AM**

A Yes. This is a chart that shows the outlines, the development and validation of the poultry litter biomarker for the state. 11:55AM

Q Who prepared this exhibit?

A This exhibit was -- well, the flowchart was prepared by myself.

Q Okay. Would you take a couple of minutes and explain to the court the methodology that you employed to develop the PCR biomarker in this case using this exhibit? **11:55AM**

A Yes.

Q You can stand up if you like or you can sit there with a pointer, either way. **11:55AM**

A I think I'm good here, that way everybody can hear me.

Q Thank you.

A Keep in mind what -- the end goal of this 11:55AM

process is have some sort of a genetic tracer that we can use to determine whether poultry litter was present in environmental samples, whether it be soil samples or water samples, groundwater, surface water, and so in order to do that, we needed to find a genetic -- piece of genetic material that came from microorganisms from the chickens, and it needed to be both specific to the poultry, broadly distributed in the waste, the poultry waste and in field samples to which these -- this litter had been land applied. So it needed to be broadly distributed and also needed to be specific to the poultry contamination source. So that's the end gain. The starting material we used to find this fragment because keep in mind, none existed, not none was existed, but none was identified before this process, was we used litter samples from poultry houses that contained chickens and those that contained turkeys, and we used samples from fields to which poultry litter had been land applied. 11:55AM 11:56AM 11:56AM 11:56AM

Q Is this all IRW based litter and fields?

A It's all material from the IRW. We utilized polymerase chain reaction and we used three separate PCR, polymerase chain reaction assays, using what we 11:57AM

call different primers. Primers are like little sticky bits of DNA that are very specific to the sequence that you're trying to amplify or make more of, and we used these -- and the PCR are all very specific in terms of the genetic material you are 11:57AM targeting. So we used separate PCR and separate primer sets to develop a pool of E. coli DNA. In one sample of poultry litter, for example, you might have ten or a hundred or even more different E. coli strains. So this DNA pool contained amplified or 11:57AM PCR amplified E. coli DNA. A second pool contained DNA from bacteria, third pool contained DNA from -- and beyond. We then used a method called terminal restriction polymorphism. This is basically going to cut the DNA depending on its precise sequence and 11:58AM give us fragments of variable lengths and what we were looking for from these DNA pools were fragments that comprised at least 20 percent of the total DNA in the pool and that also were found across all of these samples because a biomarker that's 11:58AM infrequently found in the sample type is not going to be very useful once it gets out in the environment. It simply won't be present at high enough concentration, and it won't be useful for a lot of different samples. 11:58AM

Q Doctor, let me ask you here, on the right-hand side about a quarter of the way down you have criteria, unique poultry gene samples. Is that what you just described?

A Right, that's what I described. We're looking 11:59AM for a gene that's unique, and it should say unique poultry bacteria gene because we're not really looking for a gene from the chicken, we're looking for a gene from the bacteria associated with the chickens , found in all of these samples because we 11:59AM want it to be representative broadly of litter and land applied field samples.

Q Thank you, Doctor. Please proceed.

A So we identified some candidate fragments from the TRFOP, terminal restriction fragment of 11:59AM polymorphism, that were broadly present in these samples, and then we needed to further investigate these fragments because I said that the fragments needed to be broadly distributed that we're going to look at, but they also needed to be specific to 11:59AM poultry, and so we cloned these fragments. We did DNA sequences. So we determined their exact sequence, and then we matched the sequence of those fragments up to the GenBank database. This is a world-wide database containing literally millions of 12:00PM

DNA sequences. What we were looking for in the matching to the GenBank database was we were looking for fragments, DNA fragments that have never been seen before in any other type of fecal material or in uncontaminated soil samples or in river water. 12:00PM We were basically looking for bacteria that are candidates for being poultry litter specific, and so what we found after this analysis, we submitted a lot of sequences --

MR. JORGENSEN: Your Honor, before we get 12:00PM to what we found, I've been trying not to interrupt, but I think it might be the right time. I know this is not a jury case, and that there is no Daubert hearing. Just for the Record, I want to say that we're going to make one. Dr. Harwood just testified 12:00PM that she -- no one has done this before -- found this process. Obviously I suspect you would rather for me to wait and do it all on cross and rather than make it at the end, but for the record, before the conclusion, I want to state that we're going to 12:01PM say that this could never meet the standards in --

THE COURT: Yes, sir, I understand that, and it appears that everyone is seeing it the same way procedurally as I am. Obviously Daubert is used to try to keep junk science away from juries. 12:01PM

Obviously with a judge, I can make that determination. Your objection has been made for the record. Go ahead, Mr. Page.

MR. JORGENSEN: Thank you, Your Honor.

MR. PAGE: Thank you, Your Honor. 12:01PM

Q Dr. Harwood, I think you were talking about developing new PCR markers?

A That's correct.

Q Is that what you typically do, this type of work? 12:01PM

A Yes. That is the strategy that has been employed in developing several of the most successful microbial source tracking markers that are utilized.

Q Would they develop these type of primers if 12:02PM they are doing work for a criminal case or a hospital analysis?

A For hospital analysis, yes.

Q Thank you, Doctor. Continue.

A So we were -- after analyzing many different 12:02PM fragments and determining that some of these fragments were found in environments or fecal samples that were not from poultry litter, we ended up with thee three candidate primers for -- three candidates fragments that could possibly be a good 12:02PM

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Plaintiff's Exhibit 436.

THE COURT: Doctor, I mentioned -- we touched upon this in cross examination, but to the extent the manuscript is in preparation, it hasn't been subjected to peer review or scrutiny; correct? 12:14PM

A Correct.

THE COURT: Go ahead.

Q Dr. Harwood, would you please identify for the Record Plaintiff's Exhibit 436?

A Yes. This is another map of the Illinois River watershed, and this shows the results of the quantitative PCR analysis for the poultry litter biomarker at sites throughout the watershed, and it represents results from field samples or from poultry litter samples, from edge of field samples, 12:14PM from land applied soil samples and from surface water and groundwater samples.

Q Doctor, I see a lot of black, red and green dots on the map. Could you identify those for the court, please? 12:14PM

A Certainly. The red dots all represent samples in which the amount of biomarker was quantifiable, so greater than 2,000 copies per liter. It's different units depending on whether they're talking about soil or water. For the water it's per liter, 12:15PM

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and for the soil it's per gram. The green dots show the samples in which the marker was detectable, so somewhere between 50 and 2,000 copies, but was not quantifiable. So it was not greater than 2,000.

Q What about the black dots; what do they signify? 12:15PM

A The smaller dots, the black dots signify samples that were taken where we did not detect a biomarker.

Q In those instances where there's a black dot, where there's not a detection of a biomarker, does that mean that the poultry bacteria are not present at that location where the sample was taken? 12:15PM

A Well, it doesn't mean they were never present. So we have the questions of fate and transport 12:16PM through the watershed. We also have the question of there are things we don't know about the relative rates of transport of pathogens compared to indicator bacteria and indicator bacteria and pathogens compared to the biomarker. So just 12:16PM because we don't detect, it doesn't mean that there was never any poultry contamination there.

Q Does the biomarker have a different life span in the environment than, for example, chemical?

A Well, a chemical might be expected to persist 12:16PM

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indefinitely until it gets used through biogeochemical cycling because bacteria are biological organisms, they have a certain amount of persistence time in the environment so they will not persist indefinitely over time. 12:16PM

Q What type of samples were analyzed with the PCR method?

A We analyze poultry litter samples. We analyze land applied soil samples or soil samples which received land application of poultry litter. We 12:17PM amplified edge of field samples, which are basically direct runoff from fields that had received land application of poultry litter, surface water samples, including Illinois River samples and tributary samples and groundwater samples, including 12:17PM geoprobe samples and well samples and also spring samples.

Q From the samples you analyzed for litter, what were the results with the PCR marker?

A All of the litter samples were positive for 12:17PM the biomarker, quantifiable with levels of biomarker over -- up to over a billion copies per gram.

Q What about the land applied field samples; what were the biomarker results for that?

A The land applied field samples were about 90 12:18PM

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percent positive for the biomarker, and the maximum, around the maximum value for that was 10 million copies per gram.

Q And what about edge of field, the next step in the path; what about those for biomarker? 12:18PM

A Edge of field samples about 50 percent positive and a maximum value of about 10 million per liter.

THE COURT: Excuse me just a second, Mr. Page. You say you worked with Dr. Olsen with regard 12:18PM to sampling strategy and collection. To the uninitiated such as myself, the first question that jumps to mind is I tried to superimpose the location of the poultry houses to this map. When we're talking about the area of recreational activity, 12:19PM there don't seem to be as many sampling stations, but rather that sampling is occurring in the area where these poultry houses are located, and which raises fate and transport issues. I mean, to the extent that we are really focused here in this case 12:19PM about the public health concerns, it implicates fate and transport of these bacterium from the areas of highest poultry house location. Why is it that you and Dr. Olsen didn't select more? I see that you have some green RNA results down here in the area 12:19PM

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A Compared to the ones I pointed out, yes, yes.
Q Thank you.
THE COURT: We're at 12:25. Mr. Page, care to take a break?
MR. PAGE: I would, Your Honor. 12:25PM
THE COURT: We'll take a recess until 1:30.
(Following a lunch recess at 12:25 p.m., proceedings continued on the Record at 1:32 p.m.)
MR. PAGE: Thank you for calling that 01:32PM break. May I continue?
THE COURT: Yes, sir.
Q Dr. Harwood, how many samples have been analyzed for PCR to date?
A A little bit over 200. 01:32PM
Q And how many total samples are there?
A About 550.
Q And how come your analysis ends with 200 samples?
A We had -- we received results of the sampling 01:33PM in October, November and January, and after that, we were instructed to stop submitting new results until after this hearing is my understanding.
Q Thank you. I'd like to turn your attention to Exhibit 439. Dr. Harwood, can you identify State's 01:33PM

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Exhibit 439?
A That is a graph that was prepared under my direction and it shows on the vertical axis -- well, it's a comparison of the results for the poultry biomarker assay versus the concentration of 01:34PM Enterococci in various samples, including litter, soil, edge of field, surface water and groundwater samples.
Q What does this graph tell us with regard to a relationship between the bacteria that are shown on 01:34PM it?
A Well, it tells us a couple of things. First of all, there is a significant relationship between Enterococcus concentrations and the concentration of the poultry litter biomarker in these samples. It 01:34PM also tells us something else. We talked about the sensitivity of the assay and how much needed to be present to be quantified, and so you need about 2,000 copies of the gene to quantify, and when I prepared this graph, what I did was I used the 01:34PM quantitative results for this cluster, but if a sample had presence of the biomarker, but it was not enough to quantify, then I assigned it a value of one. So that's the values down here. If the biomarker was not present, I assigned a value of 01:35PM

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zero. So that's what these are right here, but even though we do have this gap in the ability to quantify in this area, we still do have a strong correlation between Enterococci and the Brevibacteria poultry litter biomarker, and you see 01:35PM here the P value is point 0001, which means that there is only one chance in a thousand that the relationship between the variables is occurring by chance.
Q Does it tell us anything about the 01:35PM relationship between poultry waste and the Enterococci indicator bacteria we're finding in our samples?
A Well, it does say that they co-occur. So when you tend to have high levels of Enterococci, you 01:35PM also tend to have high levels of the biomarker.
Q Thank you. Now, let me show you Exhibit 438.
A That's a very similar graph except that shows the relationship of the biomarker, the poultry litter biomarker with E. coli concentration, and 01:36PM it's another of the indicator bacteria we're using for general fecal contamination.
Q Again, does it indicate anything with regard to the relationship between the E. coli that's found in the environment and the PCR Brevibacteria? 01:36PM

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A Again, and when we have high levels of E. coli, we also tend to have high levels of Brevibacteria.
Q Thank you. Again, let me show you what's been marked as Exhibit 440. 01:36PM
A This is a similar relationship, but with the fecal coliform indicator bacteria and again showing a similar trend again a highly significant correlation of point 001.
Q And does it tell us anything with regard to 01:37PM the relationship between the fecal coliform and poultry waste?
A So as fecal coliform numbers tend to be high, so does the concentration of the biomarker and vice versa, if they tend to be low, the concentration of 01:37PM the biomarker tends to be low. They are correlated. They tend to co-vary.
Q Does that mean the poultry waste biomarker co-varies with the indicator bacteria?
A Correct. 01:37PM
Q What is the chance of let's say a mistake in this analysis?
A That would be, again, the P less than point 0001, so less than one in a thousand that this relationship occurred by chance. 01:37PM

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Q Okay, and what's the date on this?
A September 14th, 2005.
Q Thank you so much. Let's turn to what in the exhibit is Page 10 but -- and not 8, but 10, but on the numbers at the bottom of the page it's 4 if you are following along on paper. I'll ask you to look at the paragraph labeled J there, source of bacteria. Let me read it and then ask you if that's right. Source of bacteria, Dr. -- 01:44PM
THE COURT: Before we read it, in an abundance of caution here, this has already been referenced, but it is subject to the earlier stipulation between Mr. Bullock and Mr. George? 01:44PM
MR. BULLOCK: Yes, it is, Your Honor.
MR. GEORGE: Yes, it is.
THE COURT: PI 275 is admitted.
Q Let's look at this again. Do you see it on your screen?
A Yes.
Q Source of bacteria: Dr. Jodi Harwood will testify that the types and volume of bacteria in the environment is likely from land applied poultry waste and viruses associated with it. Let's scroll down just a little bit. PCR analysis may be used if we obtain poultry manure samples. Did I read that correctly? 01:45PM
A Yes.
Q When did you begin your work in this case?
A April 2005.
Q And when did you come to your conclusion? 01:45PM
A Which part of my conclusion?
Q The conclusion that --
A The entire conclusion?
Q Yes.
A Really from -- the ultimate I just described, it would have been late in 2007, yes, late in 2007, because that's after we had analyzed the environmental samples with the biomarker. 01:45PM
Q Did you know before today that Mr. Page had said this would be your conclusion before you ever even finished your work? 01:45PM
A I don't know that he said that that's my conclusion since it's taken out of context.
Q How is it taken out of context?
A All I can see is that little box. 01:46PM
Q Feel free to read the page.
MR. BULLOCK: Does the witness have a copy of it, Jay?
THE COURT: I don't know.
MR. JORGENSEN: May I approach, Your Honor? 01:46PM

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THE COURT: Yes.
Q Did I read that correctly, Dr. Harwood?
A That little segment.
Q Okay. If your lawyer wants to ask you more questions about that, I'll let him do that, but the judge limits us on time, so I'm going to move on. Your testimony is quite complex, so I'm going to try to simplify it and try to explain it. So let's start by talking about your role in the case. Let's talk about what you did and what you didn't do. Is that a good starting point? 01:46PM 01:47PM
A I guess so.
Q Okay. You're not an expert in agronomic practices, are you?
A No. 01:47PM
Q You're not an expert in chemical signatures?
A No.
Q Or hydrogeology?
A No.
Q Or epidemiology? 01:47PM
A No.
Q You're not a medical doctor or a licensed physician?
A No, but can I explain something, Your Honor?
THE COURT: Go ahead. 01:47PM

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A I do use the tools of epidemiology in my work a lot, and I'm asked to explain them to managers and to the public. So I'm pretty familiar with the methodology and some of the statistics, but I'm not myself an epidemiologist. 01:47PM
Q The key point is, you're not offering medical testimony in this case; right?
A No, I'm not offering medical testimony.
Q All right. So your part in this case is microbial source tracking; is that right? 01:48PM
A Analysis of bacterial data and assessing its implications with respect to human health risks and also the microbial source tracking.
Q Okay. Let's talk about those very things. You said just a moment ago, when we were talking about fate and transport, that it's impossible to look for all pathogens; is that right? 01:48PM
A Correct.
Q But the State did look for some pathogens in this case, didn't they? 01:48PM
A Yes. Some pathogens were tested for.
Q And I believe you emphasized a moment ago that a large number of samples have been taken in this case?
A Yes. 01:48PM

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Q And the State looked for Campylobacter, didn't it?
A Yes, they did.
Q And to use an example, in the soil the State looked for Campylobacter in the soil? **01:48PM**
A Yes.
Q And is it true that the State found no Campylobacter anywhere in the soil?
A Right, but again if I could explain something briefly, that goes back to the viable but not culturable question, and the methodology which was used which was culture-based techniques, so just a clarification. 01:49PM
Q And the State looked for Salmonella in the soil, didn't it? **01:49PM**
A Right.
Q And elsewhere?
A Yes. Salmonella was identified in edge of field samples and enumerated.
Q Really? **01:49PM**
A Yes.
Q You don't agree that the State took 68 samples for soil and found none with Salmonella in them?
A No. I wasn't talking about soil. I was talking about edge of field. Soil, that could well 01:49PM

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be. I don't disagree.
Q So what the State did find was fecal indicator bacteria; is that right?
A The State did find fecal indicator bacteria, yes. 01:49PM
Q Let's bring up defendant's demonstrative 23. I think this might help lay out what we've been talking about. I think it's 32. I'm sorry to have used the wrong number. So you talked about fate and transport. You did not do a fate and transport analysis in this case? **01:50PM**
A Correct.
Q Okay. So let's talk about what fate and transport is. What do you see what's on your screen there? **01:50PM**
A Well, can I restate that for a second or can I please restate my answer?
Q Sure.
A We didn't do a specific fate and transport analysis, but we did construct our sampling regime so as to be able to assess transport routes. 01:50PM
Q Let's get into that very thing. What do you see on your screen?
A A cartoon.
Q Okay. Do you see a barn there? **01:51PM**

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A Yes.
Q And a field?
A Yes.
Q So in a traditional fate and transport analysis, would you not start at the barn and see if you could find whatever it was you were looking for at the poultry house? **01:51PM**
A You could start there.
Q Okay, and then let's see our little truck. Bring the poultry litter out, and then would you not then move to the fields? **01:51PM**
A Yeah.
Q And you looked in poultry barns, and you found fecal indicator bacteria like Enterococcus; right?
A Right. 01:51PM
Q And you looked in fields for poultry litter and you found Enterococcus there; right?
A Correct.
Q But Enterococcus is everywhere in the environment, isn't it? **01:51PM**
A Everywhere, no, it's not everywhere.
Q It's very prevalent?
A It's -- it is common in many areas, and -- but it's certainly more associated with fecally contaminated areas. 01:52PM

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Q Okay, and it comes from many sources?
A That's right.
Q As a matter of fact, almost every animal who sheds feces sheds fecal indicator bacteria?
A Correct. 01:52PM
Q So in the field I believe you said that -- let me back up. So generally speaking a fate and transport analysis, it refers to the elements and attributes that affect a bacterium's survival rate in the environment and the speed and manner with which it moves; is that right? **01:52PM**
A Those are some of the parameters that one --
Q Okay. So in a traditional fate and transport analysis, you're trying to see if something gets from Point A to Point B and how it might get there? **01:52PM**
A Yes, simplistically put.
Q And it's much more important to do fate and transport or to understand that kind of a process where you have multiple sources of the item that you're looking for? **01:52PM**
A Can you ask me that question a different way?
Q Sure. Isn't fate and transport much more complex when the items that you're studying, the bacteria that you are studying come from multiple sources? **01:53PM**

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A Well, it really would depend on your study design. I can't say that. It depends on the question that you're asking.
Q Is it easier for you to track one bacteria through the environment or multiple bacteria? **01:53PM**
A Multiple species you mean?
Q Yeah.
A It would be easier to track one species than multiple species.
Q And if the one type of bacteria comes from just one source, would it be easier to track it through the environment? **01:53PM**
A Compared to?
Q Multiple sources.
A You mean to a bacteria that comes from multiple sources? 01:53PM
Q Exactly right.
A It would again depend on the experiment design. It depends on where you were starting and where you were ending up. 01:53PM
Q All right. Well, let's move into those factors. Different bacteria move through the environment at different rates, don't they?
A I'm not aware of any definitive research on that subject. It's pretty -- it's pretty well 01:54PM

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understood that many factors affect bacterial fate and transport, but it's not well understood how fast with respect -- it's well understood, for example, that viruses move faster and farther than bacteria and that protozoa don't because viruses are small. 01:54PM
Bacteria are little.
Q Different types of bacteria move through the environment at different rates; isn't that correct?
A No, I don't -- I would not carte blanc agree with that statement. 01:54PM
Q Do you remember giving a deposition in this case?
A Yes.
Q Do you remember you being under oath when you gave that deposition? **01:54PM**
A Yes.
Q Let's bring up Page 75, Line 19 to Page 76 Line 2 in your deposition.
(Whereupon, an excerpt of the videotaped deposition of Valerie Harwood, PhD was played.)
Q "(Inaudible)."
A Did you ask me a question?
Q You're waiting to answer.
A "Bacteria move at different rates given the 01:55PM

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physical -- a lot as the physical influences upon them and also has to do with their size. So there are a lot of factors that would influence whether they -- at what rate they would move".
Q So to restate, bacteria move at different rates? **01:55PM**
A Depending on in part or in large part, I believe, on the physical and chemical factors that influence their movement.
Q And those factors can include temperature? **01:55PM**
A For bacterial movement?
Q Yes.
A It could be a factor.
Q Location within the water column?
A Yeah. 01:56PM
Q Presence of vegetation?
A Yes.
Q The media that they're moving through, whether it's grass or soil?
A Yes. 01:56PM
Q The size of the bacteria; some bacteria are big, some are small?
A Again, the size differences don't make nearly as much of a difference as the physical and chemical factors. 01:56PM

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Q And the size of the spaces that they're moving through?
A Correct.
Q All of those are factors that affect how bacteria move? **01:56PM**
A Correct.
Q So if you were to find a bacteria in the poultry house, you could not assume -- rather if you found two types of bacteria in the poultry house, you could not simply assume that they would move together? **01:56PM**
A If I found two types of bacteria in the poultry house, and then what would happen to them?
Q Could you assume they would move through the environment together at the same rate? **01:56PM**
A Well, they're in the poultry house now. Where are they going to go after that?
Q If you found two different types, two different species of bacteria in a field, could you assume that they would move at the same rates? **01:57PM**
A I wouldn't want to assume. I would want to test it.
Q Okay. I think that's right. Bacteria also die at different rates; isn't that right?
A Correct. 01:57PM

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Q A lot of factors affect how long they can survive out in the environment; right?
A Right.
Q A bacterium's ability to survive depends on its own unique genetics? **01:57PM**
A Yes, and to the -- of course, the physical chemical insults that it's subjected.
Q I think that's very important, so let's address those. So, for instance, in a field, a bacterium could be affected by sunshine, oxygen, **01:57PM**
temperature changes, humidity changes, pH changes, salinity changes, predation changes and time?
A Correct.
Q All those things would kill bacteria at different rates? **01:58PM**
A Kill or inactivate or make non-viable.
Q And a moment ago I believe you said that sunlight typically kills bacteria if it can reach the bacteria within two hours; do you remember saying that? **01:58PM**
A Well, no. I didn't say if it would reach the bacteria within two hours. I said it would kill it within a couple of hours. That's a broad estimate if the bacteria were directly exposed.
Q So if I can use an example, in a cow pie -- **01:58PM**

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this is kind of an embarrassing case. I'm just going to launch ahead. If a cow pie is a little pie with a crust, isn't it true that the bacteria inside the cow pie are protected from the sunlight or partially protected? **01:58PM**
A Yeah, yes.
Q So they would die off at a much slower rate than if they were spread out on a field?
A Correct.
Q And if you were to spread out bacteria on the **01:58PM**
field in a thin, fine dust and thereby expose them to sunlight, those would die within a few hours?
A It depends on what you mean by a thin, fine dust.
Q Thin enough that they could see the sunlight, **01:59PM**
they could be exposed to the sunlight?
A If they are directly exposed, then we're going to have a pretty high inactivation rate as long as they don't make it into the soil. If they make it into the soil, then they're probably protected. 01:59PM
Q And in talking about those same factors, dryness kills bacteria? I believe you used the word desiccation by that, but you mean dryness; right?
A Correct.
Q And that kills bacteria? **01:59PM**

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A Correct.
Q So the same thing, a cow pie shelters bacteria by keeping in the moisture; is that right?
A Compared to --
Q Compared to a thin dust? **01:59PM**
A Yeah, compared to a thin dust.
Q Now, you're not offering an opinion in this case as to the relative rates of movement of bacteria that you've studied and testified about; is that right? **01:59PM**
A Not to the relative rates of movement, no.
Q In fact, as part of your work in this case, you did not study the movement characteristics of any type of bacteria in the watershed, did you?
A No, I did not. 02:00PM
Q Nor are you offering any opinion today about the different survival rates of the different bacteria in the Illinois River watershed?
A Can you rephrase that? Sorry.
Q Are you offering any opinion today as to the **02:00PM**
relative survival rates of the bacteria that you found in the watershed?
A No.
Q And you didn't study under what conditions and how long bacteria survived in this watershed, did **02:00PM**

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you?
A No, but we have done extensive studies of that in my lab.
Q But you didn't study it here in the watershed?
A Not in the watershed, no. 02:00PM
Q Now, let's focus on the barn there on the screen. I've got that up as a representative of a poultry house. You don't know very much about the survivability of bacteria in poultry litter lying on a poultry house floor, do you? **02:01PM**
A I know that they're in a relatively stressful situation in that environment, but I think you said relative survivability?
Q Right.
A Meaning with respect to one another? 02:01PM
Q Each other, to one another.
A We know that Enterococci tend to survive better than E. coli in poultry litter. That's one thing that's fairly well-established in the literature. 02:01PM
Q And you know that poultry litter in houses is often layered; multiple layers go in?
A Yes.
Q And it sits there for a while?
A Yes. 02:01PM

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Q Do you have an opinion whether the time that passes and the layering kills off the bacteria?
A I would -- my opinion would be that -- which I haven't tested as we've established, but my opinion would be that the bacteria on the top layer of litter -- there are probably more viable and culturable bacteria on the top layer rather than the lower layers. 02:02PM
Q The lower layers would be dead or dying?
A Well, they would be stressed at least. 02:02PM
Q So you didn't study how long bacteria can survive laying out in a field after they were removed from a poultry house, did you?
A Not specifically.
Q You didn't study the specific fate and transport characteristics of bacteria moving between fields in the watershed, did you? 02:02PM
A No, I did not.
Q And you didn't study the bacterial survival characteristics in the streams in the IRW? 02:02PM
A Not specifically in the streams, although, again, we've done a lot of work in my labs. So I have a strong basis for opinions about that.
Q You're not offering an opinion in this case as to the relative bacterial survival characteristics 02:03PM

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in the streams, are you?
A You'd have to be a little more specific in your question.
Q Did you study bacterial survival characteristics in the streams in the Illinois River watershed? 02:03PM
A Not in terms of an experimental study, no.
Q All right. Let's walk through this demonstrative. So in a traditional fate and transport, you start in the poultry house, and you move to the field where the litter is applied, and then you have to track how the litter moves, if at all, how bacteria in the litter move, if at all, as they encounter an edge of a field; is that right? 02:03PM
A Well, there's all sort of ways you can design a study like that. Depends on your question. 02:03PM
Q Is that one way to design it?
A It's one way you could design it.
Q Then at the edge of a field you might encounter another field; is that right? 02:03PM
A The edge of a field would be the edge. There would be something there to stop it.
Q There would be something there to stop the bacteria from moving off the edge of the field?
A No. There -- an edge of a field means an 02:04PM

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edge. There's something else there, a road, a ditch or something.
Q Or another field?
A I'd call that the same field.
Q Okay. So it's your testimony that in the Illinois River watershed all fields end in either a road or a ditch? 02:04PM
A My concept of the term -- I'm sorry. Can I explain just briefly? My concept of what an edge of filed is, it's the end of a large, grassy expanse that would make up a field, and then there would be something that would interrupt that grassy expanse, whether it be a ditch or a ditch in a road or a structure or something. 02:04PM
Q And did you observe the sampling in this case? 02:04PM
A No, I did not.
Q So do you know if at the edge of the field, there was simply another field or it was a ditch or a road?
A In the edge of field samples that were collected in this case, there was some sort of a ditch or a depression in which water could collect because those are the water samples, the edge of field samples. 02:04PM
Q So if other witnesses have testified that 02:05PM

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there were puddles at the edge of a field, you contradict that?
A No. I said a depression or a ditch or something where it would collect the water.
Q In fact, you don't know what was at the edge of the field; isn't that right? 02:05PM
A From what I've been informed, it's usually a ditch.
Q In cases where it's a ditch or not a ditch, if there's another field beyond it, let's move through that, and then let's move through the demonstrative, and eventually you reach the stream. If the question you are trying to address in a traditional fate and transport, and this is what I'm trying to bring out, that the bacteria in the stream came from the poultry house, don't you have to track it across the environment? 02:05PM
A To demonstrate what?
Q If you are trying to show --
MR. JORGENSEN: Your Honor, may I approach the demonstrative? Maybe I can cut it short. 02:06PM
THE COURT: Yes.
Q Was the question that you were trying to address in this case, Dr. Harwood, whether bacteria that are found in the streams, whether those came 02:06PM

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from poultry litter; is that the question you are trying to address?
A Not directly whether bacteria that came from one particular field were in one particular stream, but whether there was a gradient of these signals from one compartment, in other words, from one type of sampling entity to another.
Q So the bacteria that you find in a stream, E. coli, let's take that for example, they could come from cattle; right? 02:06PM
A In certain streams there would be some possibility for contamination from cattle.
Q They could come from birds?
A There could be a bird component.
Q If you found Salmonella, it could come from reptiles? 02:06PM
A Salmonella has been isolated from reptiles.
Q So if you found Salmonella in the streams of the Illinois River watershed, it could come from reptiles? I'm not trying to trick you with these questions. I'm actually trying to clarify what you did. 02:07PM
A So if I found Salmonella at an edge of the field sample --
Q If you found Salmonella in the streams of the 02:07PM

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Illinois River watershed, they could come from reptiles?
A They could come from other sources other than that field, yes.
Q And it was your job to help the plaintiffs understand whether the bacteria that you found in water, groundwater or streams, whether it came from poultry litter? 02:07PM
A It was my job to determine whether or not there's a correlation between the practices of land applying this poultry litter and the contamination that's appearing in streams. That's how I would phrase it. 02:07PM
Q And you did not do that through a traditional fate and transport analysis; you did it through the microbial source tracking you're talking about? 02:08PM
A We did the microbial source tracking yes, as a way of determining whether or not we had a specific poultry litter signature in that water.
Q All right. Let's talk for just a moment about the animals that live in the Illinois River watershed. Pigs carry Campylobacter; is that true? 02:08PM
A Pigs are not well-known to carry Campylobacter. I'm sure there's been a couple of studies that have found that. 02:08PM

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Q And Salmonella also; don't pigs also carry Salmonella?
A Yes, pigs carry Salmonella.
Q Most reptiles, I think we established, carry Salmonella? 02:08PM
A I wouldn't say most reptiles, but I know they've been isolated in some.
Q Humans contribute fecal matter to the Illinois River watershed directly?
A Hopefully not. 02:09PM
Q You don't know whether they contribute it directly?
A No, I don't know.
Q Let's look at Page 186, Line 14 of your deposition, Page 186, Lines 14 to 21. 02:09PM
(Whereupon, an excerpt of the videotaped deposition of Valerie Harwood, PhD was played.)
Q "So humans can contribute fecal bacterial to waterways directly? 02:09PM
A Directly, yeah (inaudible).
Q Okay, and are septic systems a potential source of fecal pathogen contamination?
A Septic systems can be if they're not properly constructed to be separated from the (inaudible)." 02:09PM

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Q Dr. Harwood, you haven't studied how many species of animals live in the watershed, have you?
A No.
Q You don't know how many types of birds live in the watershed? 02:09PM
A No.
Q You haven't studied the migration patterns of birds through the watershed?
A Not directly, no. I've had some information on it, but I have not myself studied that. 02:10PM
Q You did not quantify the volume of manure deposited by each different type of animal in the watershed, did you?
A Not myself, no. Although, I have seen information on the subject again, and I know that annually in the Illinois River watershed there's about 350,000 tons of poultry litter land applied. I know that from Chris Teaf's work, that the volume of, for example, poultry litter is one of the dominant sources of fecal material contributed. 02:10PM
Q Let's look at Page 72, 19 of your deposition, 72, 19, 20.
(Whereupon, an excerpt of the videotaped deposition of Valerie Harwood, PhD was played.)

Q "Did you attempt to quantify the type of manure from each type of animal in the watershed?
A No, I did not."
Q Then let's go to Page 121, Line 25 to 122, 2 of your deposition.
(Whereupon, an excerpt of the videotaped deposition of Valerie Harwood, PhD was played.)
Q "Do you know per capita fecal production of any living animal in the IRW?" And then let's go to Page 72, Line 25 to Page 73, 3. 02:11PM
(Whereupon, an excerpt of the videotaped deposition of Valerie Harwood, PhD was played.)
Q "Did you attempt to quantify the volume of bacteria that come from each type of animal in the watershed? 02:11PM
A No, I did not."
MR. PAGE: Your Honor, I object to the use of the deposition. Her testimony was not that she tried to do it, but that she reviewed other people's 02:11PM materials, and that deposition statement there did not contradict her statements.
THE COURT: The question on the record that Mr. Jorgensen asked, I thought, had to do with an attempt to quantify the type of manure. Just one 02:11PM

second.
MR. PAGE: I believe the question, if I read it correctly was, did she attempt to quantify it.
THE COURT: You have not determined the 02:11PM volume of manure deposited by each type -- I can't make it out.
MR. JORGENSEN: I'm actually reading from a little script. So it's, you did not attempt to quantify the volume of manure deposited by each type 02:12PM of animal in the watershed, did you, and the direct response is 72, Lines 19 to 21.
THE COURT: Overruled.
Q Dr. Harwood, did you attempt to quantify the volume of bacteria deposited by pets in the watershed? 02:12PM
A No.
Q Did you attempt to quantify the volume of bacteria, I'm not talking about the manure, but the bacteria in the manure deposited by humans in the watershed? 02:12PM
A No.
Q And you don't know whether anyone else on the State's team did any of these things, do you?
A There was -- material was reviewed as to the 02:12PM

relative or the amounts of animal feces that would be deposited in or that could contribute to impairment in the watershed, but that material, that research was not done by me.
Q And you're talking about the amounts of feces, not the volume of bacteria in the feces? 02:13PM
A Correct.
Q You didn't study the effects of urban runoff on bacterial loading in the watershed, did you?
A No. 02:13PM
Q We've covered the things that you did and that you didn't do. Let's move to the science of microbial source tracking generally. Now, microbial source tracking is a young science; is that right?
A I would say it started in 1996 or so, 02:13PM depending on where you start, so, yeah.
Q Would you agree that it's still developing?
A Yes, much as all of microbiology is developing.
Q And in your direct testimony you talked about various ways that DNA is used; is that right? 02:13PM
A Yes, I did talk about that.
Q Would you agree that what you did here is unlike the hospital and criminal context that you talked about? 02:14PM

A It is like the hospital and criminal context in that it's based on polymerase chain reaction, PCR, which is, of course, a well-accepted scientific tool.
Q What PCR is, it detects the presence of DNA? 02:14PM
A PCR very specifically detects the presence of very specific sequences of DNA.
Q Okay, and PCR takes one piece of DNA and matches it with an identical piece of DNA; is that right? Using PCR, you can determine that two pieces of DNA are identical? 02:14PM
A No. You have to sequence the DNA to determine that they are identical, but using PCR, you can specifically amplify a small amount of DNA into a larger amount, and the specificity lies in the 02:14PM primers that you use.
Q And that's only one small part of what we're calling today microbial source tracking; right?
A That's really the basis of library independent microbial source tracking. I wouldn't call it a 02:14PM small part at all.
Q Let's get into that very thing then. Would you agree that until recently scientists, such as yourself, expectations of what microbial source tracking can tell us were overly optimistic? 02:15PM

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A Can you restate that? I'm sorry.
Q Do you think that the reliability of the various types of microbial source tracking that have been put forward in recent years, that the expected reliability was overly optimistic? 02:15PM
A I would say that up until about the time when Don Stoeckel published his work in -- I think it was 2003, that there was a lack of validation of microbial source tracking studies that did cause over optimism, and since then, in our science we've 02:15PM been building efforts to strengthen validation and to make these methods more and more reliable.
Q So in 2003 various people, various scientists were coming forward with various different methods of trying to determine whether a bacteria came from 02:16PM a particular source; right?
A In 2003, and they still are.
Q And in 2003 they believed that the methods that they were putting forward were reliable?
A I would say they were involved in testing the 02:16PM hypothesis of whether they were reliable. I would hope they wouldn't just believe it.
Q And you don't believe that they were wildly optimistic about the reliability of the methods that they were coming up with? 02:16PM

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A Well, I know I've used that phrase before to describe the mood.
Q Let's look at it. Could we bring up Defendant's Exhibit 89?
THE COURT: Well, now, wait. She says 02:16PM she's used the term before. This is improper to validate what she just admits she's done and said.
MR. JORGENSEN: Well, this is something that she wrote, Your Honor, and then we'll go through some of the things that she wrote. 02:16PM
THE COURT: Well, I understand, but she just said she knows she used the phrase before. Why use the time if she just admits she used the phrase wildly optimistic?
MR. JORGENSEN: We'll get more than one 02:17PM phrase out of this. We'll explore --
THE COURT: Let's ask her a question that can be impeached by what you are about to show me. Okay?
MR. JORGENSEN: That makes sense, Your 02:17PM Honor.
Q Dr. Harwood, do you remember writing an article or a presentation with Dr. Stoeckel about the validation of microbial source tracking methods?
A Yes, I do. 02:17PM

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Q And do you remember that in that article you said that people or scientists who put forward microbial source tracking methods, that they were wildly optimistic about the results?
A No. You're taking that a little bit too far. 02:17PM Basically what the slide meant was -- and it was meant to be presented in a humorous approach to giving a talk in a deadly boring scientific meeting. Okay. So initially people were over optimistic about what their methods could achieve. Then we 02:17PM learned about validating the methods, and as we've gone on, we've learned more and more and more about validating the methods, which is why Don and I wrote the paper that was published in 2007 about validation of microbial source tracking methods and 02:18PM how important that is and it spells out a series of steps to take in validation.
Q So we have lots of reasons to be skeptical of microbial source tracking, don't we?
A One would have reason to be skeptical of 02:18PM microbial source tracking methods that are put forth without proper validation.
Q And, in fact, you did a study where seven different methods of microbial source tracking that were put forward were each proven to be unreliable? 02:18PM

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A They were not unreliable. They each had pros and cons as far as their drawbacks and caveats. No scientific method is perfect.
MR. JORGENSEN: Your Honor, if I might now, we'll go to Page 3 of the presentation, and we'll 02:19PM show that the methods were unreliable.
Q Will you look here? At the top it says expectations of microbial source tracking Stage 2, ah, oh, not so fast. Do you see that?
A Yes. 02:19PM
Q In this study that is referred here, does it say below that 30 E. coli isolates were chosen randomly from the challenge sample set?
A Yes.
Q 10 of those were human? 02:19PM
A Yes.
Q 10 of those were swine?
A Yes.
Q 10 of those were Canadian geese?
A Yes. 02:19PM
Q That each of those 30 samples were sent to various scientists using microbial source tracking methods; right?
A That's correct.
Q And those scientists, they didn't know what 02:19PM

these fecal sources came from, did they? It was blind.
A They did not.
Q And the point of this study was for them to try to determine you have found feces in the environment, where did it come from, what is its source; is that right? 02:19PM
A That is correct.
Q If you look over to the right there , let's look at the one at the very bottom. This is one method, right, the results of one microbial source tracking method that was used, and it looks to me, if you look at that first paragraph, that they said there were four humans identified from the 30? 02:19PM
A Yes. 02:20PM
Q Three or four cattle?
A Samples, yes.
Q Although, again, that's wrong. There were no cattle in these samples. Three chickens, looks like nothing for dogs there, some horses, some swine, few Canadian geese, some white-tailed deer and unknown. Do you think that's a reliable result? 02:20PM
A No. This study actually showed that the -- there was several caveats associated with the study, and it would take me a long time to get into it. 02:20PM

The library sizes were very small. The number of isolates were very small, but the bottom line, these were library dependent microbial source tracking methods, and they really try to do a large -- study a large, large geographical area with a very small number of isolates, and there's all sort of reasons why this -- the researchers in this method were unable to accurately identify the sources, and it doesn't invalidate microbial source tracking. It shows what we've learned. 02:21PM
Q It shows that in 2003 the methods were unreliable?
A 2004. Remember, these are library dependent methods. These are not the same methodology that we're using. 02:21PM
Q And which method were you using here; was it antibacterial resistance analysis, ARA?
A Actually I was not part of this study.
Q At that time what method were you using in your lab? 02:21PM
A At that time I was using antibiotic resistance analysis and ribotyping.
Q Let's look at the very top study here and then we'll move on. ARA, in this sample, ARA concluded that there were 11 chickens among the 30, but indeed 02:21PM

there were no chickens among the 30; is that right?
A Oh, I can't read the bottom.
Q It's at the very top. Oh, you can't read the bottom where it says chickens?
A But, remember, my lab was not involved in this study. 02:22PM
Q But that's the method that you were using in your lab at the time?
A Not this specific ARA method that was used here, no. 02:22PM
Q In many of these studies or microbial source tracking methods at the time, the people who were putting them forward thought they were 60 to 90 percent accurate; wasn't that your conclusion in the study; that before testing, they thought their methods were 60 to 90 percent accurate? 02:22PM
A The conclusion in which study? I'm sorry.
Q The one we just referenced in the chart.
A I wasn't in this study.
Q Prior to this study, antibacterial resistance analysis, a form of microbial source tracking that you were using in your lab, was thought to be 60 to 90 percent accurate? 02:22PM
A There were papers published that said it was 60 to 90 percent accurate, but there was all sorts 02:23PM

of problems with those papers.
Q This study concluded that these microbial source tracking methods that we just discussed were only 20 to 30 percent accurate?
A Again, there was actually some problems with the study design, but, yeah, it was not accurate the way it was done but, again, we learn as scientists. 02:23PM
Q And isn't 20 to 30 less accurate than flipping a coin to determine where a source came from?
A Well, it depends on -- it's not a flip of a coin if you have a bunch of different sources, so you have assess the probability that you would arrive at a result by chance. 02:23PM
Q After this study 2003, 2004 that you participated in, did the United States Geological Survey, USGS, put out a press release specifically warning about the reliability of microbial source tracking methods? 02:23PM
A They may have. I don't know for sure.
Q Let's bring up what's been marked as Defendant's Exhibit 111. 02:23PM
THE COURT: Let's go take these one at a time unless there's an agreement that all of them come in.
MR. JORGENSEN: I think that was the 02:24PM

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agreement a moment ago. I said I'll take all of his if he'll take all of mine, and we exchanged them before.

MR. PAGE: That's correct.

THE COURT: Thank you. 02:24PM

Q Let's bring up the highlighted section. It might make it easier for you. Can you read that on the screen?

A Yes.

Q Will you read it? 02:24PM

A When a community finds that water relies on for drinking or recreation contains E. coli --

Q No, I mean the highlighted version. I apologize.

A But several types of methods using E. coli to identify the sources of fecal contamination were less accurate in field application than previously reported according to a recent U. S. Geological Survey, USGS report published in the Journal of Environment Science and Technology. 02:24PM

Q Now, you've made the point that all of this is 2002, 2004, and much has been learned since then; is that right?

A Right.

Q In fact, you wrote an article just last year, 02:25PM

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2007, in which you characterized the body of microbial source tracking literature as very difficult to interpret both for scientists and end users?

A That's correct, and that's the body of 02:25PM literature that has been accumulated since 1996.

Q You also wrote just last year that the fact is that the field has not yet reached the state where any one method can be discarded or universally recommended? 02:25PM

A Yes. That's why we rely on weight of evidence in these types of studies.

Q Hasn't the EPA said as late as 2005 there is no single microbial source tracking method that could be applied to all types of fecally 02:25PM contaminated water systems?

A Yes.

Q All right. Let's turn from the general field of microbial source tracking, and before we do, let me end with a question. So in microbial source 02:26PM tracking, what you are trying to do is you find feces in the environment, and you are trying to say where it came from?

A No, you don't find feces. You are usually looking at water bodies. 02:26PM

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Q Ah. You find a bacteria and you are trying to say where that bacteria came from?

A Or trying to say where fecal contamination in the water came from.

Q And you do that by trying to determine where 02:26PM the bacteria came from?

A Or viruses, not necessarily bacteria.

Q Now, you've carried out experiments that required sampling before; right?

A Yes. 02:26PM

Q You are familiar with good sampling practices?

A Yes.

Q When you are taking a sample of water from the edge of a field and you're trying to measure the bacterial content in the runoff from that field, 02:26PM would it ever be appropriate to take a sample from water that contained a cow pie?

A So are you asking me if it would be appropriate to take -- I'm sorry, can you restate your question? 02:27PM

Q In this case would it be appropriate to take water samples from the edge of a field from a little puddle that contained a cow pie?

A What am I trying to show again?

Q This case. 02:27PM

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A But what exactly is my question?

Q In this case, would it be appropriate to take a sample from a puddle that contained a cow pie?

A It depended upon what my goal is. If I wanted to determine if there was a high level of bacteria 02:27PM in a sample that contained cattle feces, yes. If I wanted to determine what a representative sample from the edge of field runoff was, then, no.

Q Would it be appropriate in this case to sample water where there had been evidence that the cattle 02:27PM had been recently in the water or near the water?

A Again, it might be. It would depend on what the specific question was.

Q The question in this case. Would it have been responsible for you -- 02:28PM

A To take a sample --

Q Where there was evidence that cattle had recently been in the water or near the water?

A I don't see a priority why that would be irresponsible. One might need to capture that area 02:28PM of the watershed.

Q Can we go to Page 167, Line 13 to Page 167 Line 8 of your deposition?

(Whereupon, an excerpt of the videotaped deposition of Valerie Harwood, PhD was played.) 02:28PM

A "Inaudible.
Q If one were to go to the edge of a field and take a sample of runoff water that was coming directly out of a fresh cow pie, would you expect the numbers of E. coli to be very high? **02:28PM**
A I wouldn't expect anybody to do that.
Q If that happened, would you expect the numbers to be very high?
A It would depend on how old the cow pie was.
Q Fresh? **02:29PM**
A Sure, they would be high.
Q Would they approach raw sewage?
A I don't know. I've never tried that, but I know nobody would sample that way.
Q Why would nobody sample that way? **02:29PM**
A Because that would be irresponsible. You don't go next to something that you know is going to increase your numbers or significantly decrease your numbers. You are looking for, you know, an area that will be as representative of the edge of field 02:29PM as possible."
Q When you were talking with Mr. Page a moment ago, is it true that you said it's important to follow accepted standard methods?
A I don't remember. What were we talking about? 02:29PM

Q Is it important in your work to follow standard methods?
A If they exist, yes.
Q It is it important to follow standard methods when enumerating bacteria? **02:29PM**
A If they exist for your question, yes.
Q And is it important to follow standard methods in microbiology?
A Compared to what?
Q Is microbiology a field where standard methods are very important? **02:30PM**
A Microbiology is a field where standard methods are important and where emerging methods are also important as long as they're based on reliable methods and good scientific validation. 02:30PM
Q And in this case you've excluded work that was not based on a standard method?
A Results you mean, data?
Q Uh-huh.
A Yes. 02:30PM
Q And in this case, the specific science that you are offering, the specific work that you did, it's novel, isn't it?
A The work that I did is based on a technique that is validated, reliable in many, many different 02:30PM

fields. There are aspects of uniqueness to our approach, yes, but, again, it's based on sound science and good validation.
Q The question, Dr. Harwood, is the specific science that you are offering in this case, is it novel? **02:31PM**
A I don't know if I would use the term novel. It makes it sound kind of silly, but I would say it is a development of a new methodology. That's what I would say. 02:31PM
Q It's untested, isn't it?
A We tested it.
Q It's not a standard analytical procedure?
A It's not a standard analytical procedure.
Q It's more appropriately considered developmental and cutting edge? **02:31PM**
A It is, indeed, as I said, new. It is new method development.
Q So no one else has done this before?
A Other people have done very similar studies. 02:31PM
Again the EPA own scientists are working on methodolgy. They have peer reviewed publications out. It's not something that nobody has ever done before. It's not speculative. It's based on a reliable method and strong validation procedures. 02:32PM

Q I believe you said a moment ago that it's not novel. Can we bring up Defendant's Exhibit 293? We start on Page 2 of this at the very bottom. I think we need to give some context to this; otherwise, it doesn't make sense, and we want it to be fair. Does this begin with an E-mail to Roger Olsen to various people, including you? **02:32PM**
A Yes.
Q And does he say, we are proposing to release all analytical data to the defendants. However, we don't want to release any of the PCR molecular tracking results at the time. Would the following statement preclude the PCR results, and the statement is, we will deliver to defendants copies of all chemical and bacteriological analytical results produced by standard analytical procedures and receive from commercial labs, excluding any direct expert record assessment manipulation, evaluation and our interpretation and opinions of the analytical results from all media, litter, soil groundwater, surface water, lakes, streams and sediment. All right. Let's go up to the next. That's a little bit of context. Let's go up to the next one. I think that might be on Page 1. Is that an E-mail from Kent Sorenson to Roger Olsen? **02:32PM** **02:33PM** **02:33PM**

A Yes, it is.
Q Let me read what Mr. Sorenson says. Roger, to me it comes down to your definition of standard analytical procedures. While one can argue about whether the PCR or other techniques might be considered standard, I think we would be justified in saying this stuff is not standard, given that we're dealing with a potential biomarker that has not previously been demonstrated and for which we had to design new primers. In that sense, this is uncharted territory. Did I read that right? 02:33PM 02:34PM
A Yes.
Q Let's go to the E-mail above. This -- who is that from and to?
A From Tanzem McBeth to Kent Sorenson, Roger Olsen and me. 02:34PM
Q Does Tanzem say I agree with Kent? While the PCR itself may be standard, the process of developing the biomarker procedure is not standard. In fact, we haven't even finished developing and verifying the analysis, and I think any disclosure of results at this point is premature? 02:34PM
A That was 2006.
Q Let me go down to the last sentence. The entire process is highly specialized and more 02:34PM

appropriately considered developmental and cutting edge rather than standard. Did I read that right?
A Yes.
Q And then at the E-mail the very top, who sent that? 02:35PM
A That's from me to -- oh.
Q Would you read what you said?
A I agree with Tanzem and Kent. This is method development in a relatively novel research area. Nothing is standard about it. 02:35PM
Q Now, what you identified in this case is a bacteria, is that right, the biomarker that you refused to as a bacteria?
A It's a gene from a bacterium.
Q And it's not part of a chicken's DNA. I want to make that clear. Is that right? 02:35PM
A That's right.
Q It's not part of a turkey's DNA?
A That's correct.
Q It is a bacteria? 02:35PM
A That's correct.
Q And it's your theory that this bacteria lives in chickens and turkeys; is that right?
A It's not a theory.
Q Is that your theory in this case; is that your 02:35PM

testimony in this case?
A That's my testimony.
Q Have you -- what do you base that on; why is it not a theory?
A Because of the detection of extremely high levels in poultry litter, and then it's bolstered by the fact that an organism that's at least 98 percent identical to it has been isolated from poultry feces on several occasions, and it's published in peer reviewed publications. 02:35PM 02:36PM
Q You didn't get it directly out of chickens or turkeys; right?
A Not in our work, yes.
Q Now, you've identified this bacteria as a species of Brevibacterium; is that right? 02:36PM
A That's correct.
Q Okay. I'm going to -- let me ask you a question. Before you identified this bacteria, was it known to humankind?
A The very close relative, Brevibacterium avium, was known and, again, they're 98 percent similar. I can't say if they're different at this point or not. We'd have to do more work. So it may or may not have been known. 02:36PM
Q In fact, when you ran through the database 02:36PM

that you mentioned of all known bacteria, it was not in there?
A That match wasn't in there.
Q It doesn't have a name?
A It's Brevibacterium species. 02:36PM
Q Doesn't have its own name?
A Unless it's -- bacterial systematics is incredibly complicated but basically -- if we were to demonstrate this bacteria is the same as Brevibacterium avium within a 2 percent agreement of DNA, then we would say it's the same bacterium. Again, we haven't gone far enough down that road to know. So it may or may not. 02:37PM
Q So as far as you know, it is an unknown bacterium? 02:37PM
A It's very closely related to Brevibacterium avium. So as a scientist, I wouldn't say it's unknown at all. We can culture Brevibacterium avium. We know a lot about --
Q Dr. Harwood, as far as you know, no one has previously found and isolated this bacteria? 02:37PM
A Again, it may be the same as the Brevibacterium avium. I don't know that. I don't have enough information to say yes or no.
Q When you ran it through the database, was 02:37PM

Brevibacterium in the database?
A Brevibacterium avium was in the database.
Q And it did not match this bacteria?
A 98 percent identical. I mean that -- usually we say the cutoff for the same species is 97 percent DNA identity with a 16SRRNT. So in terms of normal system microbial file genetics, which is trying to relate bacteria based on the genetics, these would be considered the same species. 02:37PM
Q As Brevibacterium avium? **02:38PM**
A As Brevibacteria avium. However, again, we need to do more to determine whether, in fact, it is the same species or not.
Q Brevibacterium avium, it's not pathogenic, is it? **02:38PM**
A It's not pathogenic to humans.
Q This new bacterium --
MR. PAGE: Your Honor, I would just request that the counsel just allow the witness to complete her statement. 02:38PM
MR. JORGENSEN: I'm sorry, Your Honor. I'll try to be more careful on that.
THE COURT: Thank you, sir.
Q Isn't it true that Brevibacterium avium is not pathogenic? **02:38PM**

A Brevibacterium avium has not been demonstrated to be pathogenic to humans. That doesn't mean it can't be pathogenic, but it's not shown to be.
Q And you have no evidence that this bacterium that you have found is pathogenic? **02:38PM**
A I have no evidence of that.
Q You have not studied the fate and transport characteristics of this new bacteria?
A I have not.
Q You don't know whether it can survive on its own? **02:39PM**
A No, I don't know whether it can survive on its own.
Q You have not studied its die-off rate; is that true? **02:39PM**
A That's correct.
Q You don't know how it's affected by temperature?
A Correct.
Q You don't know how it's affected by pH balance? **02:39PM**
A Correct.
Q You don't know how it's affected by sunlight?
A Correct.
Q You don't know how it's affected by salinity? **02:39PM**

A Correct.
Q You don't know how it's affected by predation?
A Correct.
Q You don't know and haven't studied whether it can live and reproduce on its own outside of a host? **02:39PM**
A My expert opinion would be that it certainly should be able to because Brevibacterium avium is a close cousin, so it can definitely grow on culture medium.
Q So when it's found in the environment, it could be growing there on its own? **02:39PM**
A When it's in the environment, that I don't know, but I know -- I strongly suspect that it could be cultured so that it would be growing outside of its host, but I don't know whether it could grow in the environment or not. 02:40PM
Q Let's talk about whether this new bacterium is host specific. What does host specificity mean?
A Host specificity is one of those funny words in microbiology. A lot of times I'd rather use the word host associated because almost any microorganism that you see can be found at a relatively low rate in some other organism. So host specificity would mean a strong -- in my mind host specificity means a strong association with a 02:40PM

particular type of animal, animal species or a group of animals that one could define. So we find that much more frequently in a higher concentration in that organism than you would in other organisms, but I don't think it's an absolute term. 02:40PM
Q So host specific can mean or host specific does mean that it's specific to one type of animal?
A So host specific, in the way that it's used in the literature, means that it's predominantly found in one particular type of animal. 02:41PM
Q You yourself have said that host specificity is the Holy Grail of microbial source tracking; is that right?
A I wrote that, yeah.
Q And host specificity is what a truly host specific marker is what you're searching for in microbial source tracking; is that right? **02:41PM**
A Right.
Q Because if it's not host source when you find the bacterium, it could have come from multiple hosts; right? **02:41PM**
A If it's not host -- I assume you are using the term meaning absolutely host specific.
Q Right, if it's not absolutely host specific?
A If it's not absolutely host specific, which 02:41PM

most of the markers that we use in these studies are not, then you have to weigh the caveats of what other animals might be contributing and at what levels they might be contributing to the finding, and, again, we're using the weight of evidence approach, so we're -- so we have to weigh the lines of evidence. 02:42PM

Q So my question was, if a bacterium is not host specific, then when you find it in the environment, it could have come from multiple hosts? 02:42PM

A It depends on how many other hosts you might find it in, but it could have come from any sort of cross reactive host that you find it in. Again, you have to weigh the lines of evidence.

Q The marker, the biomarker in this case you've identified, it's not in fact unique to poultry, is it? 02:42PM

A The biomarker that we identified is not unique to poultry. We found it in one duck sample out of the 10 that we analyzed and one goose sample out of the 10 we analyzed. So it certainly meets of strongly host associated, but in terms of absolute host specificity, then it doesn't. So we have to -- 02:42PM

Q So when you find this in the environment, it could have come from geese? 02:43PM

A It -- if you find it in the environment in the absence of any other lines of evidence, then you wouldn't know whether it came from geese or not. You have to weigh everything.

Q And the same for ducks? 02:43PM

A Yes.

Q And when you say you found it in one out of 10 samples, the one sample actually the feces of 10 animals in it; right?

A Right. 02:43PM

Q So as far as you know, it could be in 10 ducks?

A It was a very faint signal, and we actually used nested PCR to pick it up rather than qPCR, which is very, very sensitive and it was a very, very weak signal, and we tried to clone it, and found it in very true to our clones. So we strongly suspect that it's at a very low level in these animals and -- but we would have to go back and collect more fecal samples from that area and see if we could determine how many animals it's in. 02:43PM

Q And in addition to finding it in ducks and geese, you initially found your bacterium in cattle; is that right?

A That turned out to be a contaminant because 02:44PM

that band we found in the cattle sample was very weak and, again -- well, for the court, nested PCR is when we run two rounds of PCR, and so you are trying test sensitivity of the reaction by amplifying twice with a different set of primers. So this kind of reaction is particularly subject to potential contamination, which is why we went -- one reason why we went to the quantitative PCR assay and away from nested PCR so we wouldn't have to worry about the contamination. So those samples -- the cow samples, if it came up positive, was reanalyzed, and it came up negative from the nested PCR, and then that fecal sample was actually reextracted. So we took another big piece of that fecal sample, reextracted the DNA and then tested those samples again, duplicates of those samples, and those were negative by the nested PCR. So that provided convincing evidence to us that that first detection was a laboratory artifact. 02:44PM 02:44PM

Q To summarize, you found it in geese? 02:45PM

A In one out of 10.

Q You found it in ducks?

A One out of 10.

Q And you found it in cattle, and then when you retested, you didn't find it again? 02:45PM

A And we don't believe that that was a true positive in cattle.

MR. JORGENSEN: Your Honor, may I put up a demonstrative exhibit?

THE COURT: Yes. 02:45PM

Q This is Defendant's Exhibit 221. I'm going to use it in a demonstrative way. Defendant's Exhibit 221, may I give you one? Dr. Harwood, you tested to see if the new bacteria that you had found was present in beef, right, and cattle? 02:46PM

A Correct.

Q You tested to see if it was present in swine?

A Correct.

Q Ducks?

A Correct. 02:46PM

Q Geese?

A Yes.

Q And humans?

A Yes.

Q And you found it in ducks, geese and one time in cattle? 02:46PM

A No, we don't think we found it in cattle. We think that was a laboratory artifact.

Q You found it in duck and geese?

A One out of 10 samples. 02:46PM

Q Let's go to what is Page 8 and 9 of this exhibit. Did you test, Doctor, to know whether your bacterium is present in herons?
A Herons?
Q Uh-huh. 02:46PM
A No.
Q Coots?
A No.
Q Crows?
A No. 02:46PM
Q Hawks?
A No.
Q Owls?
A No.
Q Deer? 02:47PM
A No.
Q Any type of other bird?
A No.
Q Let's look down this list. Let's go to Page 9. Do you see this long list of over -- I believe 02:47PM
it's over a hundred different animals that live in the Illinois River watershed, different types of animals that live in the Illinois River watershed?
A Yes.
Q Did you test to see if your bacterium was 02:47PM

present in any of those?
A Nope, but can I explain something, Your Honor?
THE COURT: Yes.
A When we determined which non-target samples or other animals to validate against, we target -- we 02:47PM choose the ones that are most likely to impact the watershed based on our knowledge of the watershed. Now, small birds, like many of these here, they have small masses of feces, and their feces dry out quickly. Same with many -- most some animals. They 02:47PM simply aren't going to contribute a large microbial load to the water. So we -- it's impossible to go out and sample from all of these animals. So we target the ones that, to the best of our knowledge, are going to be the major contributors to 02:48PM contamination in the watershed.
THE COURT: You've already made that point twice before; right?
A Right.
Q I'll move on. Do you remember testifying that 02:48PM **in this case you did not try to attempt to quantify the amount of feces or bacteria from any of these animals?**
A That's correct.
Q Okay. Having identified this DNA sequence in 02:48PM

an unknown bacteria, you developed a test to detect its presence; correct?
A That's correct.
Q All right, and that's called a PCR assay?
A Correct. 02:48PM
Q And the PCR assay detects the DNA sequence you're looking for; right?
A Right.
Q And it picks up dead bacteria as well?
A So it can pick up viable or non-viable 02:48PM bacteria, depending on your -- the way you treat your sample.
Q So in your samples, the positives could have been dead bacterium?
A Well, not in the water samples because the way 02:49PM that we treat the water samples is we filter them through a membrane. It's a -- looks like filter paper, but it's got pore sizes that are very defined, and the bacteria can't go through the membranes, but free DNA could. So as long as the 02:49PM bacteria are intact, they're not going to go through that membrane. They'll be concentrated and we'll have more of them. If it's free DNA, then they won't be analyzed. It will go through the filter. Now, as far as a lot of dead bacteria being out 02:49PM

there in the environment, that's unlikely because dead bacteria lyse after a very short time lyse and other organisms use them for food.
Q Doctor -- I'm sorry. Were you finished? I didn't mean to interrupt. 02:49PM
A I was just going to finish up by saying, so in the water samples, it's extremely unlikely that there were many nonviable bacteria in that sample.
Q The fact is, Doctor, of the bacteria you tested, some percentage of them could have been 02:49PM **dead?**
A That's correct.
Q And you don't know what percentage were dead?
A Especially in the soil and litter samples, we don't know. 02:50PM
Q All right. Now, once you developed a test to try to determine whether or not the bacteria was there or not there, you tried to develop a test to amplify it, to make copies of it; do you remember talking about that? 02:50PM
A Well, that was the test.
Q It's a qPCR assay?
A Yes.
Q Let me back up. A PCR assay just says the bacterium is there? 02:50PM

spectrophotometer analysis. The report subsequently then corrected, and it simply shows that the result was zero, and then with a superscript below the detection limit of the assay. So that simply is a function of the detection limit. 02:55PM

Q The error rate?

A Of the total DNA assay. Again, doesn't have anything to do directly with the qPCR assay.

Q So there is an error rate in this process?

A This -- again, this is quantification of the 02:55PM total DNA. It doesn't have anything to do with the process of amplifying the biomarker. It's just telling us how much total DNA starting material.

Q And it's not possible to start with a minus value? 02:55PM

A Well, it is because we did, but it's not -- the minus value is simply -- it's below the detection limit of the assay.

Q So the assay is not perfect; it has an error in it? 02:55PM

THE COURT: No. She's just saying it's a quantity less than the detection level. Let's move on.

Q Doctor, in this -- we talked about a number of different processes. We talked about how you 02:56PM

discovered this new bacterium?

A Correct. Well, again, we're not sure it's a new bacterium, but it's our poultry litter biomarker.

Q Okay, and you designed an assay to identify 02:56PM the bacterium, and you claim it's poultry specific?

A Correct, with my use of the term poultry specific.

Q And you consider the peer review process to be valuable; is that right? 02:56PM

A Yes. It's what I seem to spend most of my time doing.

Q Peer review is important because it improves your work product and helps you determine whether your work is correct; is that right? 02:56PM

A Yes.

Q And, in fact, peer review can catch and correct mistakes in the process?

A Yes, sir.

Q And you yourself have caught mistakes in 02:56PM material that has been submitted to you for peer review?

A Yes.

Q And the work you are testifying about in this case has not yet gone through the peer review 02:56PM

process; is that right?

A Correct, but it has been written up for publication and, keep in mind, I'm a member of the editorial board of (inaudible), so that's my thing. What I do every week is review manuscripts. So I 02:57PM try to be very careful about my research.

Q All right. Now, the method that you've developed here to determine whether or not material came from poultry litter or elsewhere, it's entirely new, isn't it? 02:57PM

A It is based on reliable technology, not new technology, but as we've talked about, it is a method that we have developed.

Q It is a new method?

A It is a new method. 02:57PM

Q And the error rate of that method is not yet known?

A The error rate to the extent that we validated the method, we do know something about the error rate, but we can't ever completely know the error 02:57PM rate of a method.

Q As a matter of fact, what you have developed is so new that it's proprietary to you; you can own this process it's so revolutionary and unlike what has been done before; it's proprietary? 02:58PM

A I don't think so once we publish it, but I don't know. I don't know anything about that stuff.

Q Well, do you consider it to be so new and so revolutionary that you own it? That's what I mean by proprietary. You can own it; you say this is 02:58PM mine because it's unlike anything anybody has done before?

A I don't own this. It's science. I want to get it out. I want other people to see it and use it. So, no, I don't own it. 02:58PM

Q Could you own it; is it so new that it could be yours, you could say this is mine?

A I don't know. I don't do that stuff.

Q Can we bring up Defendant's Exhibit 304? Just to help you zoom in on the part I'm looking at, let 02:58PM me apply some highlighting there. Let's see. Have we got the highlighting? It is -- let me show it to you. All right. Starting right here, can I show it to you on your screen? I thought we had this highlighted, the method. 02:59PM

A Uh-huh.

Q The method -- this is an E-mail from Richard Garren to Robert George. The method developed for using DNA to track (inaudible) that's through the environment is proprietary and warrants particular 02:59PM

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protection.
MR. PAGE: I'm sorry, counsel, to interrupt. Has there been any foundation established that this witness has even seen this document before or is part of correspondence chain? 02:59PM
THE COURT: Sustained.
MR. JORGENSEN: I'm sorry.
THE COURT: Sustained.
Q Have you seen this before?
A No. 02:59PM
Q Do you agree with the assertion that your method is so new as to be proprietary?
A I don't know.
Q It is new, isn't it, and unlike what has been done before? 03:00PM
THE COURT: I think we've plowed this ground before. Let's take a break. We'll take a five or ten minute recess.
(Following a short recess at 3:00 p.m., proceedings continued on the Record at 3:28 p.m.) 03:28PM
Q Dr. Harwood, in this case you did not personally gather any of the samples that you analyzed, did you?
A That's correct.
Q But the samples that were provided to you, 03:28PM

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there were samples from ten cattle fields; is that right?
A Yes.
Q If I left this building and went and found ten cattle fields in the neighborhood and none of these 03:29PM cattle in those fields had trichinosis, does that mean that none of the cattle in Oklahoma have trichinosis?
A No.
Q Can we bring up what we previously showed, as 03:29PM I believe you called it a cartoon, Defendant's Demonstrative Exhibit 32. Dr. Harwood, because you did not study the fate and transport of the new bacterium, you do not know whether if it were in a poultry litter house or on a poultry litter field, 03:29PM whether it would move in the same manner and at the same rate as other bacteria?
A I have no reason to believe that it wouldn't.
Q Aren't bacteria -- I think we established this. Aren't bacteria of different types -- don't 03:29PM they move differently?
A I didn't agree with that. I said the physical and chemical factors that influence them are more important than their type.
Q So you do not agree that some bacteria are 03:30PM

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large and some are small?
A Some are large and some are small, but within an area -- I mean over an order of magnitude.
Q Some move quickly and some don't, you don't agree with that? 03:30PM
A Their actual movement, their motility is not going to be nearly as important as the physical forces that are moving them.
Q And if you are wrong on that point, does it call your opinion in this case into question? 03:30PM
A No.
Q Doctor, I think I mentioned before it's kind of an embarrassing case. I'll just get to the embarrassing questions. We talked before over here at the left about a number of factors that kill 03:30PM bacteria in the environment. Do you remember that?
A Yes.
Q Now, if a cow is standing in a stream and it relieves itself directly into the stream hot and wet so to speak, do those bacteria face the same 03:31PM environmental stresses before making it to the stream?
A Compared to?
Q Compared to the ones spread on the field?
A They would be different environmental 03:31PM

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stresses.
Q They don't face the risk of being killed by the sunlight on the field, do they?
A No, but they might face a lot more risk from starvation. So the stresses could be different. 03:31PM
Q Do you agree that bacteria that make it into the stream can make it into the sediments and have a greater survivability rate in the sediments?
A That can happen.
Q Now, would that be true if cattle deposit hot 03:31PM and wet into the stream also be true for ducks?
A Yes, anything that gets deposited or that gets run off into the stream --
Q When you take a sample from a stream, isn't it more to know how close the contributor was to where 03:31PM you took the sample, whether it's two miles away over dry land or ten yards away in the water?
A Usually we don't have that detailed knowledge, but if you did have the knowledge, that would be good. 03:32PM
Q And it would be good because it would make a big difference on whether the bacteria could survive and prosper and make it to the stream?
A We really don't usually split hairs that much. We're looking at a big picture. We're looking at 03:32PM

big pictures and the inputs over large land areas. So that isn't really -- that is splicing and dicing of how close the animals are the big part of the picture.

Q Dr. Harwood, do you see all the birds in this picture or do you see that there are many birds in the picture? I'm not asking you to play Where's Waldo and find them all. 03:32PM

A They look like Christmas ornaments. Those are birds I guess.

Q Okay. The Christmas ornament looking things, those are birds. Do you agree that there are many birds in the Illinois River watershed?

A I'm sure there's a lot of birds.

Q And you did not test whether any of these bird species, other than ducks and geese, carry your new bacterium? 03:33PM

MR. PAGE: Your Honor, I think we've been over this now.

MR. JORGENSEN: It's a setup. I've been criticized for not doing the foundation. 03:33PM

THE COURT: I think we have covered it. Go ahead.

Q Would you expect bacteria that are carried by birds to be widely dispersed throughout the region? 03:33PM

A They would be -- they could be deposited in a wide pattern. Birds in my experience in the studies I've conducted are generally not large scale contributors because, again, their fecal masses are relatively small, and they dry out quickly, and they frequently don't reach the watershed. 03:33PM

Q Well, I appreciate that testimony, but at risk of being criticized for raising it again, you've gone back to fecal contributions, both mass and number of bacteria. You did not study that in this case. Have we not been over that? 03:33PM

A That was my opinion but, no, I did not study it in this case, but I've studied it a lot in other areas.

Q Do you recall submitting affidavits to this court, two of them? 03:34PM

A Yes.

Q In the second one, did you say to the court that you had discovered this new bacterium?

A The second one concerned the poultry litter biomarker, yes. 03:34PM

Q And did it mention to the court that you discovered you had new bacterium?

A I don't think that's how I phrased it, but I know it was about the poultry litter biomarker. 03:34PM

Q The poultry litter biomarker you call a biomarker, I call the new bacterium. Are we talking about the same thing?

A Yes.

Q And in that affidavit did you not say that it's closely related to Brevibacterium casiot? 03:34PM

A Yes.

Q But today you said it's closely related to Brevibacterium avium?

A It is. It's very closely related to both of them. 03:34PM

Q Now, you warned the court I believe in your affidavit, did you not, of the dire consequences of Brevibacterium casiot?

A No, I didn't say anything about dire consequences. 03:34PM

Q Did you not discuss the symptoms of Brevibacteria casiot?

A Yes, and I also said that it's an opportunistic pathogen, which is an organism that doesn't have to swimming (inaudible) -- 03:35PM

Q In saying that to the court you were talking about casiot?

A Correct.

Q Not this bacterium? 03:35PM

A Correct.

Q Because you have no evidence about whether this bacterium is pathogenic?

A Correct.

Q And isn't it true that bacteria that are closely related to each other do not share the same pathogenic characteristics in many instances? 03:35PM

A That's correct.

Q Many of us carry E. coli; isn't that right?

A Yes. 03:35PM

Q And it's perfectly harmless to us?

A Yes.

Q As a matter of fact, a type of Brevibacterium is used in making cheese; is that right?

A Yes. 03:35PM

Q Brevibacterium avium -- Brevibacterium is the genus; right?

A Correct.

Q And avium is the specific bacteria?

A It's the species. 03:35PM

Q Avium, is it called avium because it was found and cultured in birds?

A In poultry.

Q So Brevibacterium is found in birds and your new bacterium is found in birds? 03:36PM

A The bacterium avium is in poultry, from poultry.
Q Which are birds?
A Yeah. Brevibacterium in general, the genus is not generally a bird-related genus. 03:36PM
Q Interestingly, your bacterium you found in every bird species you've tested?
A We found it at low frequency and low concentrations in duck and goose.
Q So the answer is yes? 03:36PM
A Yes.
Q Do you recall this chart that is up here? I believe it's been marked State's Exhibit 434. Do you recall talking about that?
A Yes. 03:36PM
Q And when you were talking about that, was the subject that you were discussing whether fecal indicator bacteria, not pathogens, whether fecal indicator bacteria are correlated with the presence of pathogens? 03:36PM
A This is actually discussing whether fecal indicator bacteria are correlated to risk of disease to recreational water consumption.
Q Okay. I'm glad you clarified that. So you were talking about whether the presence of fecal 03:37PM

indicator bacteria, which are not soils pathogens, can correlate with disease?
A That's correct.
Q Is that not a topic that is hotly debated among scientists? 03:37PM
A No, it's not a topic that's hotly debated. The debate is only over the extent to which the fecal indicator bacteria are correlated if there is disease and over whether that -- whether that should continue to be the sole indicator of human health 03:37PM risk from recreational water use.
Q Dr. Harwood, didn't you draw this chart from a publication of Professor Wade?
A This came from Wade, et al, 2003.
Q May I approach, and give you a copy of the 03:37PM full Wade article?
A Sure.
Q It's been previously marked Plaintiff's Exhibit 77. Doctor, can I ask you to turn to what on my page has been parked as 1105. That's the 03:38PM original publication, Page 1105. All right. Can we bring that up on the screen? No, no. You got the wrong page. Can we have the highlighting on that? No. Once again, we're pulling up the wrong thing. Please go back to the regular page. Do you have 03:38PM

highlighting right here? That's right. Pull that up. This is the same publication from which you drew this. Let me read -- do you see that highlighted quantitative relationships between indicators, fecal indicators and GI illness fresh 03:39PM water?
A Yes.
Q Bacterial indicators of fecal contamination. Here Professor Wade is talking about this subject, whether you can correlate fecal indicator bacteria, 03:39PM which are not themselves pathogens, with disease.
A He's not talking about whether you can correlate. He's talking about whether the Meta-Analysis found the correlation.
Q Whether he found correction in the 03:39PM Meta-Analysis, and that analysis is based on a number of studies; is that right? Let me read the final sentence. No increase in relative risk was observed for high levels of Enterococci compared with low levels. So his conclusion is there is no 03:39PM correlation between high levels of Enterococcus and human disease?
A In these particular studies. In other studies there has been in fresh water, and the Enterococcus standard has been borne out more recently in EPA 03:40PM

epidemiology studies. So they're not backing off of their recommendation on Enterococcus indicator bacteria in fresh water.
Q So despite this, do you stand by your testimony that the correlation is settled in the 03:40PM scientific community?
A That's not a phrase I would use, that the correlation is settled. I'm not sure what that means.
Q Dr. Harwood, would you agree with me that it 03:40PM is not settled in the scientific community whether and to what extent there is a correlation between fecal indicator bacteria and human disease?
A I disagree. It's well-known that there is a correlation between fecal indicator bacteria and 03:40PM disease. The question in the scientific community is how many indicators should be used, which one in which circumstances and what methodologies can we use to bolster our prediction of the risk to human health in recreational water use. How can we make 03:40PM it a better system.
Q Did professor Wade not say no increase to relative risk?
THE COURT: He's talking about Enterococci. He says in the sentence beforehand E. coli is 03:41PM

pile Defendant's Exhibit 221. It should be right there on your left.
A I see it.
Q Could you just read what the title of that document is? **04:02PM**
A Preliminary -- affidavit by Billy R. Clay, MSDVM, DAVBT.
Q Who is it prepared for?
A Prepared for the defendants in the preliminary injunction, State of Oklahoma, et al, versus Tyson Foods, et al. 04:02PM
Q Would you turn several pages in to the page that's Bates numbered D2210007, please? Are you there?
A Yes. 04:03PM
Q Do you see a chart in the lower half of that page?
A Yes.
Q Does it say on the chart how much wet manure annual tons are produced by geese? **04:03PM**
A Yes. 48.
Q 48?
A 48.
Q Tons?
A Yes. 04:03PM

Q And how much for duck?
A 40.
Q And how does that relate to the amount of waste that Dr. Engel calculated in this case for poultry in the IRW? **04:03PM**
A For poultry that was about 350,000 tons.
Q Now, Mr. Jorgensen asked you a lot of questions about birds, and he showed you his drawing of the -- I guess it was a pasture with the creek and birds on it, and he asked you if you did any **04:04PM**
sampling or analysis of impacts of birds' waste in the watershed?
A I remember.
Q And you testified that you didn't do any specific analysis in this case, but I think you said **04:04PM**
you did do some analysis in other areas about impacts of bird waste on indicator bacteria?
A Yes. In Florida we have some relatively large bird populations. So that's always a consideration when we -- when we try to determine where indicator, 04:04PM
fecal indicator bacteria are coming from in these systems. So one of our common practices is to go out where we know that birds frequent and sample there, and we've never found elevated levels in areas where there are a lot of birds. 04:05PM

Q Do you have any reason to think that that analysis would be inapplicable to the Illinois River watershed?
A I think it would be highly analogous because, again, in Florida we have high abundances of even 04:05PM
large birds like herons and wood storks, and they tend to congregate and roost and, in fact, their fecal components are readily diluted and washed away, and so they don't contribute in such a large measure to elevate water quality or sorry, degrade 04:05PM
water quality.
MR. PAGE: Thank you, Your Honor. I pass the witness.
THE COURT: Mr. Jorgensen?
RECROSS EXAMINATION
BY MR. JORGENSEN:
Q Dr. Harwood, I believe you just testified that Campylobacter is commonly associated with poultry meat, and poultry meat is one of the primary ways people get Campylobacter infection? **04:06PM**
A Correct, one of the ways. They're also acquired through waterborne use.
Q In your sampling in this case you tested poultry litter, not the meat, but the litter?
A Correct. 04:06PM

Q A number of times for Campylobacter?
A Correct.
Q And found zero?
A That's correct.
Q Let's talk about PCR. I'm not sure if I did a **04:06PM**
good job before, so I'll try one more time and then it will be the old college try, I'll quit. There's multiple elements to this PCR analysis, aren't there, multiple steps?
A Yes. 04:06PM
Q And some of the steps, such as taking DNA and making a copy of DNA, are widely used?
A Yeah, and if you want to say widely used, as I mentioned before, there's lots and lots of studies going on using PCR and microbial source tracking. 04:06PM
Q Whether your microbial source tracking method is accurate in saying this came from a chicken and not a horse, sheep, duck, bird, deer or cow, depends on whether that piece of DNA is specific to chickens? **04:07PM**
A Depends on whether that bacterium is strongly associated, so distributed in those poultry to a much greater extent than it is in any other type of animal.
Q Okay. I think I got that now, and you don't **04:07PM**

A Yes, I have. Essentially when you determine the nature and extent of contamination, that always involves trying to figure out, you know, where the source is, a source identification. You have to know the sources before you clean up the site, and that's one of the objectives. There's always been besides over those hundreds of sites I've worked on that I've been asked specifically by clients to identify sources in the environment. 04:23PM

Q How many sites have there been where you've been specifically tasked with identifying the source of contamination at an environmental site? **04:23PM**

A All those, over 100 sites plus more.

Q Do you have techniques that you typically employ when you go about the process of determining sources of contamination? **04:23PM**

A Yes, we do. It's always a weight of evidence approach. We like to put all the pieces together, and a variety of techniques we use. One of the main ones we use is a pathway sampling approach. It's looking at the site conceptual model and getting samples in all the various environmental components clear from where the source could be to where it ends up. We also do other types of spatial analysis, spatial sampling, upgradient and 04:24PM

downgradient, potential sources. If we can get actual sources, we would analyze those, too. We compare results with standard waste profiles to see if they match to determine sources. We look at indicator parameters of particular sources that may be prevalent within the basin. We look at unique indicators also, for instance, like the PCR that Dr. Harwood has been talking about. We do trend analysis like Dr. Fisher talked about in the cores, looking at concentrations changing with time. We also do simple correlations like he did, and we also do some additional more sophisticated statistical analysis. 04:24PM 04:24PM

Q Did you employ those techniques in evaluating the source of contamination of this site? **04:25PM**

A Yes, I did. I took into weight many of those types of techniques.

Q They form the basis of your opinions here today?

A That's right. 04:25PM

Q Now, Dr. Olsen, just briefly tell us the clients that you've been employed by to specifically identify sources of contamination.

A Again, that would be the EPA. Department of Justice specifically employed me to determine 04:25PM

sources, municipalities, state governments and some private industry, too.

Q Have you done any work for the Department of Defense in identifying sources of contamination?

A Yes, Department of Defense, too. 04:25PM

Q How about the Corps of Engineers?

A Yes, sir.

Q How much of your work in identifying sources of contamination has been for the US EPA?

A Boy, over the last 23 years at CDM I would probably say at least 50 percent of my work or more. 04:26PM

Q Dr. Olsen, do you have experience with employing a method called principal component analysis or PCA for source identification?

A Yes. That's one of the statistical methods that I referred to that I would use in my weight of evidence approach. 04:26PM

Q Could you briefly for the court tell us what PCA or principal component analysis is?

A Yes. I might say that it's used in many, many sciences, different scientific fields, but for environmental sites it's used on sites that have a large number of contaminants, and then we use PCA to really determine all the differences and relationships between all of those contaminants that 04:26PM 04:27PM

are present.

Q And how is it used in an environmental site?

A One of the main chief things it's used for is to identify sources.

Q Sources of contamination? **04:27PM**

A Yes, sources of contamination.

Q Now, Dr. Olsen, is PCA or principal component analysis -- I think I'll use PCA for now, although, sometimes we get thrown off with PCR -- but PCA, is it recognized in the scientific community as a reliable method for identifying sources of contamination at environmental sites? **04:27PM**

A Yes, it is. I did a quick review of peer reviewed literature and found over a dozen papers that had used PCR as a technique to identify sources. 04:27PM

Q PCR or PCA?

A PCA. You got me confused already. PCA to identify sources of contamination.

Q Which clients have you used PCA for to identify sources of contamination? **04:28PM**

A I've used it for Department of Justice, EPA, three private clients, two state agencies.

Q Have you used -- excuse me. Have you published anything with regard to PCA? **04:28PM**

Q And the experts for the particular area, for example, the stream expert would critique and evaluate the plan for sampling at the streams, for example?

A The stream expert actually came in and said -- trained the people on how to do some specific things that he was the expert in doing and was there throughout the sampling, some of the sampling to make sure it was being done right. 05:08PM

Q I want to call your attention to Exhibit 375, which is before you on the counter. Can you identify that exhibit, please, sir? 05:08PM

A That's just a brief description of some things about CDM and gives some examples of projects that we've done that are similar to these. 05:08PM

Q Thank you, sir. I want to change topics on you here. Was principal component analysis one method that was used to identify the source of contamination in the IRW?

A Yes. It was one of those weight of evidence methods that I used. 05:09PM

Q Okay. Again, remind us what is PCA?

A PCA stands for principal component analysis. Again, environmental sites that have a large number of contaminants. It's a statistical technique that 05:09PM

allows us to determine the relationship of all those contaminants and the difference of all those contaminants among each other.

Q Now, Dr. Olsen, did you employ PCA to determine whether or not there was a unique poultry waste signature that could be identified in the waters of the Illinois River watershed? 05:09PM

A Yes, I did.

Q And did you reach any conclusions with your evaluation? 05:09PM

A Yes, I did.

Q What are those conclusions?

A First of all, I identified a unique combination of contaminants in the basin that was a poultry signature, and this signature was by far the most dominant signature in the basin and across all the samples. 05:10PM

Q Did that combination of contaminants, did it include both organic and inorganic constituents?

A Yes, it does. 05:10PM

Q And what constituents did it have from an organic basis?

A Well, the organic part of that was -- I guess you could call the bacteria organic or the total organic carbon we measured was organic. We measured 05:10PM

all the metals. We measured all the nutrients. We measured some organic compounds called estrogens. We measured a variety of those. We measured general water quality chemistry, major anions, cations, TDS, TSS, things like that. 05:11PM

Q The poultry signature you'll testify about includes both chemicals and bacteria?

A Yes, it does. The second thing we identified in doing this, we identified a second unique combination of contaminants at the site and that combination was identified as the wastewater treatment plant signature in the basin, and it's also present, but not as a major signature as the poultry waste is. Then last of all, we identified a set of chemicals that were related to cattle waste, and that signature, although I wouldn't call it a signature, but it was a unique combination of chemicals that I could identify cattle waste, but it wasn't prominent enough or didn't create a large enough single -- signature to be called an actual definitive signature in the basin. 05:11PM 05:12PM

Q Under PCA analysis?

A That's right.

Q Okay. Did you reach any conclusions with your comparison between poultry waste signature and 05:12PM

wastewater treatment plant signature?

A Yes. Those signatures were distinctly different.

Q Did you reach any conclusions when you compared the poultry waste signature to the cattle waste analysis? 05:12PM

A Yes. Those were completely different also.

Q Dr. Olsen, I've put up on the tripod, I think before you there's an exhibit marked as State's Exhibit 451, and I will note for the Record, Your Honor, this is a demonstrative exhibit we prepared. 05:13PM

THE COURT: So is it your desire -- typically we don't admit demonstratives. Is it your desire we not admit these three demonstratives?

MR. PAGE: If it assists in the court's evaluation, the court should have them. Other demonstratives have been admitted so far. 05:13PM

THE ARBITRATOR: I did admit these. Just curious.

MR. PAGE: I would request they be admitted. 05:13PM

THE COURT: I think we already did. I mean, I just did, did I not? I just went through that list, yeah.

MR. PAGE: I was trying to point out for 05:13PM

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Q How did that affect the number of samples you evaluated?
A We had to drop 17 samples from the analysis, and those were all samples collected very early in the program and associated with some bad bacteria 05:47PM
data we had very early in the program. Essentially we had to drop them because we no longer had the 20 out of the 25 parameters we needed.
Q Was that the FoodProtech data?
A That's right. 05:47PM
Q And how many then total samples of what you used were dropped?
A Again, we dropped 17. The analysis I just talked about and presented was based on 621 individual samples. We now have -- without the 05:47PM
rejected -- not including the rejected data, we have 604 samples.
Q Okay, and did this rejection of the rejected data cause your opinions to change in any material way? 05:48PM
A No, not at all.
Q Would you briefly just explain what Exhibit 454 is?
A 454 just shows the -- the runs with and without the rejected data. On the left is what we 05:48PM

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call the A, that's Principal Component 1, that's the chicken poultry signature that I've been testifying to, and on the right is the same analysis done without the rejected data. You can see they're almost identical, all the high factors are similar. 05:48PM
THE COURT: Just one second, Doctor.
MR. GEORGE: I apologize for interrupting. I believe that the court's ruling was that the witness could certainly acknowledge that an error was made and state that it did not change his 05:48PM
opinion, but now he's giving the substance of the new analysis in testimony.
THE COURT: I expected some of this to come up in redirect and recross. So I think that the objection is well taken at some point. I understand 05:49PM
where we are and the doctor's testimony was consistent with what was told the court earlier about rejected data. So Mr. Page.
MR. PAGE: I'll pass the witness, Your Honor.
THE COURT: Mr. George?
MR. GEORGE: Your Honor, I'm afraid if I get started, you won't want me to stop. It's going to be so exciting.
THE COURT: That concerns me as well. I 05:49PM

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know we have to handle some documents here, try to nail that down. So we've got an hour and a half tomorrow morning. If we start at 8:30, that will take us until 10:00, and how many -- we have two other witnesses for the plaintiff? 05:50PM
MR. BULLOCK: Yes. I'm sorry.
THE COURT: And you say one hour for Taylor?
MR. BULLOCK: Yes. His direct last time I timed it was an hour and 24 minutes. 05:50PM
THE COURT: All right. We'll get him done by 11:00 and --
(Whereupon, a discussion was held off the Record.)
THE COURT: Your third witness, how long? 05:50PM
MR. BULLOCK: That's Dr. Lawrence, and we anticipate that direct to be less than an hour on him, Judge.
THE COURT: Okay.
MR. McDANIEL: That's next Monday the 3rd. 05:50PM
MR. GEORGE: Tomorrow we have the completion of this witness and Dr. Taylor; correct?
MR. BULLOCK: Correct, and we've got some very brief depositions, and that's it, and we'll run through the depositions quickly. 05:50PM

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THE COURT: All right. Let's get started. I'll stop you at about 6:10, and then we'll get started on exhibits.
CROSS EXAMINATION
BY MR. GEORGE:
Q Dr. Olsen, good evening. You and I have met before on one occasion?
A Yes.
Q It's a pleasure to see you again. You're employed by Camp, Dresser & McKee; is that correct? 05:51PM
A That's correct.
Q How much has Camp, Dresser & McKee been paid for its work in this case, sir?
A I do not know the exact number. I'm not involved in the financial aspects of the project, 05:51PM
but it probably is on the order of 5 to 6 million.
Q Do you recall in your deposition taken approximately three weeks ago that at that time you estimated it was 6 million?
A Okay. 6. 05:52PM
Q Sir, you continue to work, I presume, since then along with other folks at Camp Dresser; correct?
A Yes.
Q Who has paid the 6 million dollars; the 05:52PM

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attorney general's office?
A No.
Q Who?
A It's the law firm of Motley Rice.
Q Sir, your role in this case as I understand it, I don't want to oversimplify it so you tell me if you disagree, has been to investigate environmental conditions in the Illinois River watershed and the cause of those conditions; would you agree with that? 05:52PM
A Yes.
Q And in addition to conducting that investigation, you have served as the technical director for the scientific team, if you will, of experts working on behalf of the attorney general's office; correct? 05:52PM
A Yes, I helped coordinate all the other experts.
Q Sir, do you agree that although scientifically valid, a scientist must go into his or her work with an open mind? 05:52PM
A Yes.
Q It would be contrary, would it not, to the scientific principles of the scientific method to form your conclusion first and try to secondarily 05:53PM

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identify data to support that conclusion; correct?
A Certainly.
Q Sir, did you go into this project with an open mind with respect to the sources of potential contamination in the Illinois River watershed? 05:53PM
A Yes. I certainly did.
Q I'll put Defendant's Exhibit 275 on the screen for you, please. This has already been introduced. Do you recognize this memo? It's been discussed. Do you recall it? 05:54PM
A No. I'd have to look at it.
Q Can you identify the fax cover sheet?
A It's faxed to me from David Page.
Q Has David Page been the attorney that you worked with most closely on this case? 05:54PM
A Yes.
Q This memo was sent to you by Mr. Page it appears on September 14th of 2005; is that correct?
A That's what it says.
Q And, sir, this memo is discussing back in September of 2005 the legal and factual basis for preliminary injunction motion; correct? 05:54PM
A I don't know. I can look at it to see.
Q Take a moment and look at it to refresh your memory. Sir, you've seen this document before, 05:55PM

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have you not?
A I've not looked at this for a long time. I don't remember the contents of it.
Q Can you turn to page -- I think it's numbered 3 at the bottom, but it will be Page 9, I believe, on our equipment here. Do you see the heading C? 05:56PM
A Yes.
Q Edge of field samples and analysis?
A Yes.
Q Can you read the last sentence of Mr. Page's words to you in this memo dated September 14th of 2005? 05:56PM
A Proximity of field plus principal component analysis by CDM to show bacteria is associated with land applied poultry waste. 05:56PM
Q Is it not true, sir, that back in September of 2005 before you ran any PCA analysis in this case and before you collected the 2,661 samples that we have heard discussed in your direct testimony that Mr. Page had informed you that your result from your PCA would be to show that bacteria is associated with land applied poultry waste in edge of field samples? 05:56PM
A He didn't tell me to do anything. I let the cards fall like they are. The analysis was done. 05:57PM

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The sampling was done, and the principal component showed what it did. I didn't manipulate anything at all.
Q Exhibit 273, please. Dr. Olsen, I'm going to hand you Exhibit 273. Do you recognize Exhibit 273? 05:57PM
A That looks like a status report that we periodically do. This looks like a draft one. It isn't a finalized one.
Q Who would author the status reports, sir?
A Darren Brown would typically author them, and then I would review them along with Ron French. 05:57PM
Q Sir, do you see your little signature -- I'm sorry, your Bates number down in the bottom right-hand corner as evidence this came from your file? 05:58PM
A Yes.
Q And, sir, this status report is dated what?
A Status report of June 22nd, 2005. It isn't a complete memo, so it doesn't say when it was issued.
Q Can you turn to the third page of that status report, please, under the task 3.9 bacteria analysis by PCR? 05:58PM
A Yes.
Q Do you see the name of someone who just testified before you in that seat, Jodi Harwood? 05:58PM

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Q You haven't quantified it, have you, sir?
A That's right.
Q You've done no statistical analysis to allow you to provide more detail on vastly improved; correct? **06:03PM**
A That's right.
Q It's just your gut feeling; right?
A No. Sir, those principal components are very well defined. The signatures are very well defined. The vast majority of impact is associated with 06:03PM
principal component 1. If you eliminate that, it will vastly improve.
Q The principal component analysis that we've been discussing is a statistical tool, would you agree? **06:03PM**
A The first part of it was steps 1 through 7 that I identified is a statistical tool.
Q The principal component analysis simply allows you to look at relationships within a dataset regardless of what the dataset is; correct? **06:03PM**
A It goes further than that. It creates a score that I've talked about in step No. 7 that tells you how that's related to various principal components and the magnitude of that impact. It also tells you how prevalent that score is throughout the basin. 06:04PM

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So it just doesn't tell you about relationships.
Q Sir, would you agree that the principal component analysis can only compare data that you have selected and put into the database?
A Data in, data out. I mean, you only analyze 06:04PM
what you put in. I mean, that's a given fact.
Q How many samples did you include in your principal component analysis run, your most recent one?
A The ones that met my criteria were 620. 06:04PM
That's essentially the total set of samples that we analyzed for the extended list of parameters.
Q So, sir, out of the 2,661 samples that you testified at length that you collected, you've only analyzed through your PCA analysis 600; correct? **06:04PM**
A 621 and let me tell you why.
Q I think you've already testified to why with regard to the number of parameters.
A No, I haven't. You know, most of those samples were not designed -- 06:05PM
Q Sir, you'll --
A Could I explain?
THE COURT: Well, I'm sure Mr. Page will ask that. Go ahead.
Q Sir, the data that you chose not to include in **06:05PM**

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your principal component analysis would include samples such as fecal matter collected from cattle; correct?
A No. They were in there.
Q You took samples from -- **06:05PM**
A Excuse me. I misspoke. We had samples that were substantially impacted by cattle, and that's how I could tell that those were different. I did not specifically take samples of fecal matter from cattle. However, we ended up with springs and edge 06:05PM
of field samples that had cattle in them.
Q Let's break it down, if we can, sir.
A Sure.
Q Included in the dataset, the 600 samples that you ran your PCA analysis on would be surface water samples; correct? **06:05PM**
A That's right.
Q Groundwater samples?
A That's right.
Q Soils? **06:06PM**
A No.
Q No soil samples?
A That is an analysis, just surface water for now. There's no solid litters at all. This is how it impacts the basin as far as surface waters and -- 06:06PM

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Q There's no poultry litter in the PCA analysis?
A No, there isn't.
Q Let me refer you to Demonstrative 459. Can we put that on the screen? I thought I heard you testify in direct examination that the depictions on the left, Principal Component 1 coefficient the orange bars, reflected litter samples. Did I misunderstand? **06:07PM**
A You certainly did.
Q So what do the orange bars reflect? **06:07PM**
A It was consistent in everything I said. Those orange bars reflect Principal Component 1 based on surface water samples.
Q So you're comparing in this chart, if I understand correctly Principal Component 1 for surface samples with over on the right-hand side a solid poultry litter and solid cattle waste? **06:07PM**
A That's right. The theory is that if it's in the solid waste, some of it is going to leach out into the environment, and it should create a similar 06:08PM
pattern with the surface water principal component score. That isn't the case in all cases. For instance, calcium leach is very different from cow manure than it is from poultry litter. Copper leach is very different because it's mobilized with the 06:08PM

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organic carbon in the litter. So you have to consider leachability when you get this comparison, too, but generally you can see that everything that's high is in the solid materials, also high in that surface water Principal Component 1, which is the poultry. 06:08PM

Q Let's go back to sampling if we can, sir. The State's consultants through CDM collected cattle manure samples in this watershed; correct?

A They didn't specifically mean to collect cattle water -- cattle samples but there were springs that had cattle samples, cattle waste in it, and there were some edge of field samples that had cattle waste in it. 06:08PM

Q Let me stop you. I think maybe we're miscommunicating. Is it not true in connection with the work that was done by Dr. Harwood that CDM representatives collected actual samples of cattle manure from the watershed? **06:09PM**

A Yes. That was -- I'm glad you clarified that. That was only done for the quantitative PCR analysis. 06:09PM

Q Okay, and you took those cattle samples of waste, and you took them to a lab and had them analyzed in terms of their chemical composition? **06:09PM**

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A No.

Q You did not?

A No.

Q You could have sent it to a lab and had it analyzed? **06:09PM**

A We plan to collect cattle samples now and do the exact same thing.

Q Why haven't you done it already?

A Well, you can see that this is the way principal component works. If the waste is there and it's significant, for instance, the cattle waste or the wastewater treatment plant, but the sampling we did, you're going to see that waste signature if it's significant. We, of course, saw the wastewater treatment plant signature. We didn't see the cattle signature. My conclusion is the cattle signature is not significant. I went to specific samples that I knew had cattle waste in it, and I could see a distinct difference particularly with the poultry waste. So I knew what I was looking for, and it just wasn't a dominant signature across the basin. I found it in like significantly in one spring sample, and I found it not significant in three other spring samples. I found it significant in four edge of field samples and not so significant in 06:09PM 06:10PM 06:10PM 06:10PM

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five others. It's not a dominant signature across the basin. If it would have been, I would have found it.

Q You are answering a question other than the one I asked, sir. If at all possible, I would ask that you keep your responses to my questions. Dr. Olsen, your comment that you validated your belief that you can exclude this cattle signature by going back to a specific location, is limited to the information you have about which edge of field samples and which fields are affected by cattle; correct? **06:10PM** **06:11PM**

A No.

Q Sir, you don't know with respect to all the places you collected edge of field samples in this watershed that you believe are poultry litter signature samples, the extent to which those areas are impacted by cattle, do you? **06:11PM**

A I know exactly what waters and what edge of field are impacted by cattle and which are not because it has a completely different chemical composition, and I can tell the difference. 06:11PM

Q Let me move away from how you are interpreting the results and let's talk about what you actually know about the field. With respect to the edge of **06:11PM**

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field locations where you have detected what you believe is a poultry litter sample, you don't know for all of those locations, do you, sir, the extent to which cattle are grazing in that area?

A Well, most of them have cattle -- 06:11PM

Q Sir, do you know?

A No, I do not know for sure.

Q You're assuming with respect to all edge of field samples, that you have identified a poultry waste signature based upon the PCA analysis that unless you had a photograph or someone told you that there was a cow there, that that chemical composition reflects poultry; correct? **06:12PM**

A Absolutely not. You're absolutely wrong. If it has cow waste in it, I can see it. If it has chicken waste, I can see it. They're different. 06:12PM

THE COURT: This might be an appropriate place to stop. You have an hour and ten minutes left in cross examination. We'll start again at 8:30. Please, lawyers, stick around, and we'll get this exhibit problem taken care. We'll take a short recess, and we'll be back on the record. 06:12PM

(Whereupon, the hearing was recessed a 6:14 p.m.)

(Whereupon, the hearing began at 8:29 a.m.)
THE COURT: Mr. Olsen, would you take the stand? Mr. George, you may continue.
MR. GEORGE: Thank you, Your Honor.
CONTINUED CROSS EXAMINATION
BY MR. GEORGE:
Q Good morning, Dr. Olsen. Sir, when we last left, we were talking about your principal component analysis; do you recall that?
A Yes, sir. 08:29AM
Q Sir, if I understand correctly, the principal component analysis is performed through some statistical software; is that right?
A Yes, sir.
Q What is the name of that software? 08:29AM
A We used a combination of Excel and Sysstat, and at a basic level.
Q And that's about the level which I understand, so you can straighten me out if I'm wrong, sir. The principal component software takes the data that you 08:29AM decide to give it; correct?
A Yes.
Q Okay, and it looks for relationships within that data between the list of parameters or constituents that you select; correct? 08:29AM

A And all the samples, yes.
Q What you get out of the software on the principal component analysis is a bunch of statistics; is that right?
A It's a printout with coefficient factors. I 08:29AM guess you could call all those statistics.
Q Let's look at one of those printouts. Let me hand you, Dr. Olsen, my copy, what I've marked as Demonstrative Exhibit 35. Dr. Olsen, I printed out this spreadsheet from the materials that you 08:30AM produced in this case. Do you recognize it?
A I do not. Let me see. I think this was one of the runs that we performed. I'd have to look for sure, but it looks familiar.
Q Dr. Olsen, is this the format in which you 08:30AM received output from the PCA software?
A This is just one of the outputs, and this was for a smaller set of contaminants than we ended up with the final analysis.
Q This is some of the data or stats you would be 08:31AM looking at in trying to make a determination as to the presence or absence of a signature; correct?
A Yes.
Q If you look on the first page, let's talk through this a little bit. It doesn't have a page 08:31AM

number, does it? Do you see, sir, the list of the variables on the left-hand side?
A Yes, sir.
Q What are those variables?
A Those are the contaminants that were analyzed 08:31AM for.
Q Across the top there is a listing of factors; do you see that?
A Yes.
Q And it appears to me it goes Factor 1 through 08:31AM Factor 5; is that right?
A Yes.
Q What are those factors?
A Those are the principal components that we've been talking about, Principal Component 1 and 08:32AM Principal Component 2 that would correspond to Factor 1 and Factor 2 in this run.
Q Okay. Now, beneath each factor is a long number that begins with a decimal; correct?
A That's correct. 08:32AM
Q And those numbers are loading values; is that correct?
A These particular ones here are correlation coefficients. If you -- under the no rotation, they're actually directly proportional to the 08:32AM

coefficients or the loadings we actually use. So it's a number that would be similar, but they aren't the actual numbers used in the final analysis of the component score.
Q Now, Dr. Olsen, with respect to the factors, 08:33AM Factor 1 through 5, the computer does not identify those as poultry; correct?
A No, that's right.
Q This is not a situation where you feed a bunch of chemical data into a computer and it prints out 08:33AM the word poultry as a source; correct?
A That's correct.
Q Now, let's go back a little further in the documents to the percent variance page. Can you find in the materials I've handed you the page that 08:33AM shows percent variance; you're familiar with that term?
A Yes.
Q And we'll pull it up on the screen. Sir, now, the computer generates a value for each factor 08:33AM amongst this data that was analyzed in terms of percent variance explained; correct?
A Yes.
Q I think you told me in your deposition, this is what you look at in making a determination about 08:34AM

chemical signature; correct?
A I said that was one of the factors, you remember, the overlying factors was try to keep as many parameters as possible and still explain the maximum percent of the variance. 08:34AM
Q Right. But percent variance, the higher the percentage, the more comfortable you are with the idea that the factor described explains something in the data; correct?
A As long as you have enough parameters in there. So there's those two things you have to weigh back and forth. 08:34AM
Q Sir, how many parameters were on this run of your PCA analysis?
A Nineteen. 08:34AM
Q Again, sir, on this page of the output, the computer doesn't identify Factor 1 as poultry and Factor 2 as point sources. Those are your determinations; correct?
A That's right. 08:35AM
Q You, Roger Olsen, look at these statistics and you decided to call Principal Component 1 the poultry signature; correct?
A No. As I explained yesterday, I did several things. I ordered the factor score so it isn't 08:35AM

these statistics I looked at, and I also compared the signature for all those variables to known waste compositions.
Q But those are your determinations, not the software's determination; correct? 08:35AM
A Yes, and that's exactly what I tried to say yesterday.
Q Your determination as to whether Factor 1 is a poultry signature or something else is one that you make using your own judgment; correct? 08:35AM
A That's correct.
Q You decided, did you not, sir, that Principal component No. 1 in your PCA runs represents a source of contamination as opposed to just normal variation in the data; correct? 08:36AM
A That's correct.
Q You decided that Principal Component 1 represents a single non-point source of contamination from poultry litter rather than a combination of different sources; correct? 08:36AM
A That's correct.
Q Sir, have you subjected those conclusions regarding your interpretation of these results as indicating a poultry signature to the formal peer review process to allow scientists other than those 08:36AM

retained by the Motley Rice law firm who are experienced in interpreting PCA results to evaluate the soundness of your methods and conclusions?
A You mean like to a journal or something like that? 08:36AM
Q Yes, sir.
A No, we haven't at this time. We plan to do that.
Q Dr. Olsen, out of all the scientists in the world who have studied water quality in areas where 08:36AM poultry production occurs, you're the only one, aren't you, sir, that holds the opinion that the list of parameters that we saw in your direct examination constitute a poultry signature?
A Well, that poultry signature is specific to 08:37AM this basin, and I'm the only one besides other scientists in our company and one outside reviewer that's looked at this. So no other people outside the group or our scientific reviewer has seen this, so no one else has made that conclusion. 08:37AM
Q You recall being asked these same questions in your deposition, sir?
A Yes.
Q Let's look at what you said in your deposition. I want to play two clips back to back 08:37AM

if I can. Page 120, Lines 13 through 18 and Page 121, Lines 3 through 122, Line 2.
(Whereupon, an excerpt of the videotaped deposition of Roger Olsen, PhD was played.) 08:39AM
Q Dr. Olsen, you were here during the examination of Secretary of the Environment Tolbert?
A No, I was not.
Q You were not here for that. Were you here for opening statements? 08:39AM
A No.
Q You are aware, are you not, sir, that the Illinois River watershed and in particular water quality in the Illinois River watershed has been the subject of numerous reports from universities and 08:39AM government agencies for at least the last 20 years?
A Yes, I'm aware of some of those studies.
Q Sir, and have you seen in any of those studies a suggestion by any of the authors that they believe that the list of components on Plaintiff's 08:40AM Demonstrative 455 which you have described as your poultry signature for -- I'm sorry, your chemical signature for poultry is a reliable way of identifying poultry litter applications as the source of contamination? 08:40AM

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A No, no one has ever looked at such an extensive list before.
Q Have any of the authors in the studies that you've seen suggested that a combination of zinc or potassium or total dissolved solids, total organic carbon, aluminum, sulfate, alkalinity, that those things are indicative of contamination from poultry waste? 08:40AM
A Certainly there's been many suggestions that many of those parameters related to poultry waste, but no one has ever identified that unique combination of 25 that I did. 08:40AM
Q Let's talk about the unique combination of 25, sir. Do you see on the screen the list of principal components? 08:41AM
A Yes, I do.
Q And the one on the left-hand side, Principal Component 1, is the list of parameters that you believe in various concentrations are a chemical signature for poultry litter; correct? 08:41AM
A That's correct.
Q Sir, is total organic carbon unique to poultry litter?
A No, it isn't.
Q You find total organic carbon everywhere in the environment, don't you? 08:41AM

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A In varying concentrations you find it, from very small to very large. In chicken waste it's a huge amount.
Q Do you find total organic carbon in soils? 08:41AM
A Yes, you do.
Q Copper, do you find copper in soils; correct?
A Yes, you do, but it's, again, the amount. We find so much more of it in the waste than we do the soils. 08:41AM
Q With respect to this list that is in front of you, are any of the 25 components that you used in your analysis unique to poultry litter?
A No.
Q Sir, are every one of these components found in other sources that are known to exist in the basin in varying concentrations? 08:42AM
A Most of those would be -- well, again, you have to determine detection limits. Like for cow, essentially there's -- or wastewater treatment plant, there's essentially no arsenic and no copper. So there's some there, but you just can't detect it, and then compared to poultry waste, those are very, very large numbers. So when you say if it's present or not, you really have to talk about an analytical 08:42AM

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detection limit. So some of these would not be present in other wastes.
Q Which ones would you not find in another waste in this watershed?
A Well, there's always some, but many of the analyses I've seen from wastewater treatment plants for like arsenic were below detection limit. Same for either zinc or copper. 08:43AM
Q Let me stop you because I think maybe you are answering a different question. Are there any of these you would not find detectable in at least one source other than poultry litter that's present in this watershed? 08:43AM
A Well, by source you're meaning everything?
Q Everything. 08:43AM
A I'd have to review, but, again, some of the trace metals, you would find those in soils, of course, but particular waste, you may not find some of these trace metals. I'd have to review all the other sources, which I haven't reviewed all the other sources. I've reviewed wastewater treatment in cattle. 08:43AM
Q Dr. Olsen, soils are a source of contaminants in the water in the Illinois River watershed; correct? 08:44AM

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A They run off with it, with the -- when you have runoff, the soils are incorporated, but it turns out that those trace elements that are in the soils are not soluble, whereas in poultry waste they're very soluble, and that's why we find them. 08:44AM
Q Dr. Olsen, one of your parameters that you have identified as part of your unique signature for poultry is calcium; correct?
A Yes.
Q Sir, were you here when Dr. Fisher testified? 08:44AM
A For part of that.
Q Did you hear Dr. Fisher describing the limestone that underlies much of the Illinois River watershed?
A Yes. 08:44AM
Q And what is limestone composed of, sir?
A Calcium carbonate.
Q If you look at your list of components, there are three different types of phosphorus, are there not, in your signature? 08:45AM
A One point on the calcium, it's negatively related to the signature.
Q Sir, if you could stay with my questions, your counsel will follow up with you. I only have limited time. I don't mean to be rude at all. With 08:45AM

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respect to phosphorus, Dr. Olsen, there are three different types of phosphorus in your signature; correct?
A Yes.
Q One of them, total phosphorus is a combination of two of the others; correct? 08:45AM
A Not a direct combination of the others.
Q Well, phosphorus SRP and dissolved phosphorus would be two of the things that go together to comprise total phosphorus; correct? 08:45AM
A What was that again? SRP is soluble reactive.
Q Dissolved phosphorus.
A Those two don't add up to give you total. They're different.
Q Are they included in total phosphorus? 08:45AM
A The total up here, they're included in that, yes, sir, but they're different.
Q You included nitrogen in your chemical signature for poultry. Nitrogen is found naturally in the soils; correct? 08:46AM
A There's several forms of nitrogen I've included. Depends on what form you are talking about, but it's found in soils.
Q I'm talking about the form in your signature.
A Well, the one that's found in the signature 08:46AM

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that's most prevalent is total kill nature. That's both organic nitrogen plus ammonia. It's a specific type of nitrogen, and it relates to the type of nitrogen you find in the various components.
Q That type of nitrogen is found naturally in the soils? 08:46AM
A In some soils, yes.
Q In the soils in the Illinois River watershed, you know that to be true, don't you?
A There is some organic nitrogen in some soils. 08:46AM
Q Sir, potassium is found naturally in the soils in the Illinois River watershed; correct?
A That's correct.
Q You collected litter samples, and you had them analyzed for a lot of things beyond the 25 there on your list; correct? 08:47AM
A That's correct.
Q You know, do you not, sir, that nickel is found in poultry litter?
A There's some concentrations of nickel in poultry litter. I'd have to look up those exact -- 08:47AM
Q Isn't it, in fact, true, Dr. Olsen, that you detected nickel more commonly in the environment than you did many of the things you included in your signature? 08:47AM

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A I don't think that's true. I'd have to go back and look at the data.
Q If nickel is in poultry litter, why is it not in your poultry litter signature?
A Again, this is -- this signature is based on actually what leaches from the field and what gets into the environment. If it didn't show up in the actual water samples, it wouldn't be part of the poultry signature. 08:47AM
Q What happens to the nickel? 08:47AM
A It doesn't leach into the water.
Q Nickel doesn't move from a field that's received poultry litter, but you believe the aluminum does?
A In some cases, yes. It depends on what is tied up, but the nickel is a very, very small concentration, if I remember correctly, and it isn't a parameter that would be a significant contributor to the signature. We're looking at significant contributors here. 08:48AM
Q Dr. Olsen, it also contains chromium, lead and molendinum. Too many consonants in it.
A Yeah, and we looked specifically at those, and even though they contain it, they contain it at very small quantities in cases that are not much 08:48AM

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different from natural soils, sometimes littler than natural soils. So it wouldn't contribute to a signature at all, and that's why they're not in here.
Q Your chemical signature for poultry litter includes some things that aren't even chemicals; right? 08:48AM
A There's some bacteria in there.
Q Even beyond bacteria, there's some physical properties in your list; is that correct? 08:49AM
A I don't see any. Can you point one out to me?
Q Alkalinity, what is alkalinity, Dr. Olsen?
A It's a measure of specific chemicals.
Q Isn't alkalinity the capacity of water to neutralize acid? 08:49AM
A Well, no. That's one definition. Here the alkalinity is defined as how much carbonate and bicarbonate you have in the system, which is chemicals, but you're right. It's a titration, but it's a titration of chemicals usually defined as how much carbonate and bicarbonate you have. So it's a chemical signature. 08:49AM
Q You consider alkalinity to be a chemical property as opposed to a physical property?
A Certainly. It's a titration, as you said. 08:50AM

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That's a chemical property.
Q Dr. Olsen, you testified earlier. We're going to pull up State's Demonstrative Exhibit 467, Dr. Olsen. You testified from this on direct examination, put it on the screen, and I'll ask you a question about it. 08:50AM
MR. PAGE: Your Honor, just for the Record, in anticipation of the issue of a supplemental data. We prepared for the defendants both groups depending on how the court would rule, so there's an A group and B group on these exhibits, and Dr. Olsen actually testified yesterday to 466, which doesn't have the supplemental data. 08:51AM
Q Let's go to 466.
MR. GEORGE: Thank you, Mr. Page. 08:51AM
Q Do you recognize State's Demonstrative Exhibit 466?
A Yes, I do.
Q If I understand your testimony on direct examination, these are the percentages in the samples that you used in the principal component analysis where you believe you have detected the chemical signature for poultry; is that correct? 08:51AM
A One clarification on this. This is by location, not by samples. 08:51AM

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Q Okay. So Dr. Olsen, with respect to the edge of field samples, 100 percent and the groundwater samples 60 percent, those percentages do not include the 2,000 samples that were excluded from your principal component analysis; is that right? 08:52AM
A They only include the samples that have enough parameters to do the principal component analysis.
Q I believe you testified yesterday that was about 620; correct?
A 621, yes, for this set. 08:52AM
Q So the remaining samples, approximately 2,000, you could not find enough of the parameters on your list in those samples to make them useful in the PCA analysis; is that correct?
A Well, most of those samples, a lot of those samples are not water samples of the poultry waste, soils. The sediment you have to take out right away, and the others were designed for a less set of parameters. We did not analyze all those samples for the extended list of parameters. So there's a reduced list here that we can use, and that number is approximately 621. 08:52AM 08:53AM
Q Dr. Olsen, if we factored back in the 2,000 samples where you didn't have enough of your parameters to run the PCA, what would your 08:53AM

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percentages on this chart look like?
A You couldn't do the analysis, sir. The PCA blows up or doesn't work when you have holes in it. That's why we have to select the list that we do and make some rules. 08:53AM
Q Well, sir, if a given sample does not even have enough of the parameters to allow the PCA to analyze it, isn't that an indication that the chemical signature you believe you identified from poultry is not in that sample? 08:53AM
A No, that's not correct at all. You misunderstand what we are doing here.
Q You think on the samples where you don't even have, for example, phosphorus and aluminum detected that even those are components of your signature, that the chemical signature still might be present in those samples? 08:53AM
A Yes, if we analyzed the complete suite of parameters, we would have had much -- a lot of those -- about the same percentage, I would say, of all those samples would have had chemical signature. It's just that some of those samples were not analyzed for a complete list. 08:54AM
Q Why not?
A Well, one of the reasons is that we were 08:54AM

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trying to -- remember yesterday I described setting up stratified sampling designs, and one of the things I've talked about was collecting over 200 samples just for indicator parameters like phosphorus and nitrogen, and from that set we did a stratified design and picked a subset of samples where we could do all the analysis. So the analysis that we did for the complete analysis were set up on a surface water, were set up on the stratified designs that I collected yesterday. It's just impossible cost-wise to actually analyze for that many parameters and that many samples, so we created a scheme where we had a representative set where we analyzed for all the parameters. 08:54AM 08:55AM
Q Dr. Olsen, let me refer you to State's Demonstrative Exhibit 459, which is a chart you prepared. You'll recognize it when it comes on the screen, I suspect. Do you recognize that chart, sir? 08:55AM
A Yes, I do. 08:55AM
Q You prepared that; correct?
A Yes, I did.
Q And if I understand it, the point of this chart is you're comparing concentrations in poultry litter of various constituents with literature 08:55AM

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values for cattle; correct?
A There's a couple of things. First of all, I just compared the actual waste analysis with the signature, poultry waste analysis from the basin. So that's the first column, and I actually compared those numbers to literature poultry waste, and the last column that you are referring to is the comparison to literature values for cattle waste if I could find values. 08:56AM
Q Let's talk about the first piece of that. You said you are comparing the poultry litter samples with the principal component coefficients on the left-hand side; is that correct? 08:56AM
A That's correct.
Q The two things you are comparing are not the same, are they; the thing on the left-hand side Principal Component 1, is a coefficient; correct? 08:56AM
A Yes. I'm comparing the relative concentration and the size of the bars to make sure that that pattern and the most important bars are consistently -- those parameters are consistently found in the poultry waste. I'm not comparing coefficients for actual concentrations. 08:56AM
Q The bars on the left-hand side are not concentrations, are they? 08:57AM

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A That's right.
Q Okay. So the longer the bar, for example, for copper, does not mean that in order to be a match with your signature, you have to have a greater concentration of copper than you do, say, barium; that's not the way this chart works, is it? 08:57AM
A Well, somewhat. No, it doesn't work that way at all, but the longer the bar, the more important that parameter is. So we need to make sure that all those are present in poultry waste. 08:57AM
Q Dr. Olsen, the way the software works, even a constituent with a small concentration could be very important to the signature; correct?
A That's typically not the case because all those relationships and some of them are relatively small to others because you're right, they are all related, but they all should be present in poultry waste. 08:57AM
Q They all should be present. Is that all it takes to qualify? 08:58AM
A No.
Q Dr. Olsen, let's take an example here. Organic matter in poultry litter, you've listed it at 730,000 milligrams per kilogram?
A That's correct. 08:58AM

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Q Now, copper, which is next, the second most important one on your list is not the second highest concentration, is it?
A No.
Q It's 420 milligrams per kilogram? 08:58AM
A Yes.
Q Let's move over to the literature for cattle waste. Why were you relying upon the literature as opposed to actual samples?
A We didn't collect any actual samples and analyze them. 08:58AM
Q Well, you collected cattle manure samples, didn't you?
A Just for PCR.
Q But you had cattle manure in your possession, you could have sent it to a lab and had it analyzed for all the things you believe are indicative for your signature of poultry litter? 08:58AM
A That's correct.
Q You chose not to do that? 08:59AM
A No. At that time those samples weren't big enough to analyze for all these parameters, and they were specifically collected for PCR.
Q Now, Dr. Olsen, there are several rows in the column for your literature cattle waste that have a 08:59AM

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line in them. What does that mean?
A They're white. That means I couldn't find a literature value for that particular parameter.
Q Did you search hard for literature values?
A I did not do an exhaustive search. I was just trying to do a comparative analysis to see if there was a difference. 08:59AM
Q Why wouldn't you do an exhaustive search?
A Well, the fact is, sir, that if the PCA identifies a different signature and we know from this it's different enough that it will give a different signature, we would see it in the basin. So the real proof of identifying sources is what signatures you see in the actual samples from the basin. 08:59AM 09:00AM
Q Dr. Olsen, when you say we see in the basin, you mean you, I see in the basin; correct?
A Yes, with input from the other experts.
Q You know, do you not, that cattle manure contains E. coli, Enterococcus and total fecal coliforms? 09:00AM
A Yes, I'm aware of that, and I haven't made any statement that it didn't.
Q And after 6 million dollars worth of work in this case, you couldn't find a single piece of 09:00AM

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literature that reported the concentrations of E. coli, Enterococcus and total coliforms in cattle manure?
A Again, I didn't do an extensive list. I'd be glad to get any literature and add it to this list, if we can. 09:00AM
Q Did you consult with Dr. Teaf to see if he had any literature on the presence of bacteria in cattle?
A No, I didn't. 09:01AM
Q Were you aware Dr. Teaf had performed computations as to the number of fecal coliform bacteria in cattle?
A I was aware he was doing some computations on that. 09:01AM
Q Let's go down to phosphorus, soluble reactive phosphorus and soluble phosphorus. You know, do you not, that cattle manure contains soluble phosphorus?
A Yes, it does. I couldn't find a value for that in the literature. 09:01AM
Q After all the money you've been paid and all the time you spent on this case, you couldn't find literature that would report a value for total phosphorus for cattle manure?
A Yes, I didn't do an exhaustive list of trying 09:01AM

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to find all the parameters.
Q Who did your search for you?
A I had our librarian do our search for waste, cattle waste analysis, and she did a computer search for that. 09:01AM
Q Did you explain to the librarian that you were going to present this information to a federal court and you needed it to be as complete as possible?
A She did -- I told her what to search for, and she searched all the journal articles available and all the databases she could find to do this. 09:02AM
Q Dr. Olsen, you also collected samples of human waste from septic tanks as part of your work in this case; correct?
A I did not collect those. Those were collected for the PCR analysis. 09:02AM
Q Did somebody working with your company, Camp, Dresser & McKee, collect samples of human waste from septic tanks?
A Actually those were collected by staff from Lithochimeia. 09:02AM
Q But you're the technical director, you knew the work was going on?
A Yes, sir.
Q Did you take the samples and have the samples 09:02AM

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analyzed to determine the presence, absence and concentration of the 25 parameters you are using in your chemical signature for poultry?
A No, we did not.
Q Why not? 09:02AM
A At the time that was -- the program was designed specifically for qPCR.
Q Dr. Olsen, who actually set up your computer program and all of the statistical language and macros that's involved with that to run the PCA analysis? 09:03AM
A Dr. Rick Chappell.
Q Dr. Rick Chappell is no longer with your firm, is he?
A No, he is not. 09:03AM
Q Sir, let me hand you what we've marked as Demonstrative Exhibit 34, which is, sir, a treatise entitled introduction to environmental forensics, and I'll ask you to take a moment and look through that. The listed author is Brian Murphy and Robert Morrison. Sir, have you ever had occasion to consult this particular treatise? 09:04AM
A No, I have not.
Q I'm going to read some statements out of it and ask you -- that discussed PCA and some of its 09:04AM

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limitations and ask whether you agree with them. Let's start, if we can, on Page 5 -- it's listed at 510, the summary section, and, by the way, for the Record, Your Honor, what I put in front of the witness and I provided a copy, of course, to counsel 09:04AM for plaintiffs, is the cover page, the copyright page, and then this is actually a multi-chapter treatise. I've included the paragraph on principal component analysis, which is Chapter 12. Do you see at the bottom of Page 510 in the summary section, 09:05AM the very last paragraph. There should be some highlighted language in your copy.
A There's two highlights. Which are you referring to?
Q Let's talk about the last one first. Let me 09:05AM read it, and I'll ask if you agree with this. PCA, the earliest of the procedures discussed in this chapter, work best in simple cases where there are few sources contributing to the system and there's limited mixing between sources. If an initial PCA 09:05AM indicates the presence of mixtures, it is usually best to move to a data analysis method capable of resolving the nature of that mixture. Do you see that?
A No, I don't see where you are reading. 09:06AM

Q It's on the screen and should be highlighted. Let me look at your copy to make sure you have one that's highlighted.
A I didn't follow you at all there.
Q Let me do it again. I want you to follow me. I want to read it, and it should be on the screen, and I highlighted it, Dr. Olsen. PCA, the earliest of the procedures discussed, works best in simple cases where there are few sources contributing to the system and there is limited mixing between sources. If an initial PCA indicates the presence of mixtures, it is usually best to move to a data analysis method capable of resolving the nature of that mixture; do you see that? 09:06AM
A Yes, I do. 09:06AM
Q Do you agree with that statement?
A Let me read that again. Let me see. Works best for simple cases where there are few sources contributing to the system. Again, we only have a few sources here contributing to the system. I 09:07AM wouldn't say it's a simple case. I think PCA works for these very complex cases, and there is limited mixing between the sources. Actually we didn't find a lot of mixing between the sources. It was very clear when we had mixing and when we didn't, and we 09:07AM

could identify that mixing, and overall, there was limited mixing of the sources in our analysis, and it's very clear when we did the PCA scores on everything and compared scores 1 and 2.
Q Dr. Olsen, if I understand what you've just said, you believe that the Illinois River watershed is a system which only receives input of the things on your list of parameters from a few sources, two? 09:07AM
A No. There's three major sources out there, and we were able to identify two, and we were able 09:08AM to identify when those two sources mixed together, and we see that out there frequently. There is a third source, cattle source. We were able to identify specific samples of where that was, and those few specific samples were mixed with the other 09:08AM samples. So I would say there was limited mixing overall, and we could identify where that was.
Q Dr. Olsen, if you could turn back a few pages to Page 464 in this treatise. There should be a highlighted paragraph, which I'm going -- we can read it all, but I'm interested in some particular things. You'll see it on your screen, Dr. Olsen, but I'll certainly give you time to find it in your paper, too. Do you have Page 464 in front of you? 09:08AM
A Yes, I do. 09:09AM

Q Do you see the first paragraph?
A Yes.
Q I'm going to read you some portions of that paragraph and ask whether you agree, sir. Regardless of the data analysis strategy chosen, another important consideration is the presence of bad or questionable data. Common problems with environmental chemical data include the following: Chemical analysis performed by different laboratories or by different methods which may introduce a systemic bias. The presence of concentrations at or below detection limits, the presence of coclution, the ever present problem of error in data entry, data transcription or peak integration. Dropping down, sir, to the next sentence. Unfortunately such errors rarely manifest themselves as random noise. More often they contribute strong systemic variability. If unrecognized, the result may be a derivation of, quote, fingerprints, which have little to do with true sources. Do you see that language, sir? 09:09AM 09:09AM 09:10AM
A Yes, I do.
Q Do you agree with that as a description of the problems associated with bad or highly variable data used in a PCA analysis? 09:10AM

A With bad data, not with -- with bad data, not with high variability data. You're looking for data that has a lot of variability.
Q Poor term on my part. What about bias data?
A Yes, and all these four things that are listed 09:10AM here we checked very carefully in our analysis when we did it.
Q Dr. Olsen, there were multiple laboratories who ran analysis that the results of which were used in your PCA; correct? 09:10AM
A Yes, but those laboratories were always doing the same set of analysis, sir, so there wasn't like a variety of labs doing the same analysis. Same lab did all the different analysis.
Q Sir, your counsel will give you a chance to elaborate. Please answer my question so my time is not all consumed. How many laboratories were involved in the results you used in your PCA analysis? 09:11AM
A Three. 09:11AM
Q Okay. Just three?
A Yes, one for the bacteria, one for the phosphorus and one for all the other parameters. That's just three.
Q Can you list those three labs for us? 09:11AM

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A Environmental Microbiological Laboratories did the bacterial analysis. Aquatic Research did the phosphorus analysis, and A & L did the rest of the analysis, all the metals and general water quality parameters. 09:11AM

Q Sir, you left out FoodProtech, did you not?

A Yes, I left that out. They did some analysis up front, but because they had bad data, we dropped them very quickly.

Q How quickly did you drop the FoodProtech data? 09:12AM

A Oh, that was within probably a half a year after we started, five or six months. So there is some FoodProtech data left in our analysis, and I forgot to mention that. I'm sorry, but it's a very small amount. 09:12AM

Q Even after the problem with FoodProtech was identified and their bacteria data was rejected by Dr. Harwood, you continued to use the results of samples run by FoodProtech in your PCA analysis; correct? 09:12AM

A No, that's not correct. She did not reject all the data. In fact, at her suggestion they actually changed one of their procedures. After that time there was some good data, and there was only two or three of the actual analyses out of the 09:12AM

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seven they were performing that she actually rejected.

Q You're continuing to use FoodProtech data in your PCA analysis?

A Just the valid data is all we're using. 09:13AM

Q When did Dr. Olsen determine that the bacteria data produced by FoodProtech was invalid?

A I did not determine that.

Q I'm sorry. When did Dr. Harwood determine that? 09:13AM

A I can't remember that. We got her involved early, but I think it's consistent with what I said. It was still the first year we were sampling, and I actually started to use EML so we had some comparison. So it was probably in late 2005, 09:13AM sometime in that time frame, autumn 2005.

Q You said you testified that you dropped the FoodProtech data from the PCA analysis that had been rejected by Dr. Harwood; correct?

A Yes, data for the most recent runs. 09:13AM

Q How many PCA runs in support of your chemical signature analysis did you perform with the rejected FoodProtech data still in there?

A There were a substantial number until I discovered that some of that rejected data was still 09:14AM

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there.

Q Let's quantify. You're up to PCA run 9 today; correct?

A I don't have any recollection what you mean by PCA run 9. There's been lots of runs, and we didn't 09:14AM number them like that.

Q Do you quarrel with the notion you've run your PCA at least nine times?

A We've run it -- we've run it hundreds of times, sir. 09:14AM

Q You ran your PCA database analysis hundreds of times?

A Yes.

Q With the FoodProtech rejected data?

A No, I didn't say that. I said overall we've 09:14AM run it that many times.

Q Well, sir, you just pulled out the FoodProtech data about two weeks ago; yes?

A Yes, and we've done substantial runs since that time to verify that everything was still valid. 09:14AM

Q Have you run it hundreds of times since then?

A No, I didn't testify to that, sir.

Q And every time that you ran that PCA analysis with the rejected FoodProtech data in it, you saw the chemical signature for poultry, didn't you? 09:15AM

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A Yes, I did.

Q Sir, one of the other factors listed as problematic by the authors of this treatise is the presence of data at concentrations at or below method detection limits; do you see that? 09:15AM

A Yes, sir.

Q You had difficulty in this case, did you not, sir, with samples that reported consistently some of the constituents used in your PCA analysis at or below the detection limits? 09:15AM

A I don't know what you mean by the word difficulty. That's an expected result. There were results with --

Q A lot of the data you were working with in your analysis included samples that had reported 09:16AM values below the detection limits for the things included in your poultry signature; correct?

A No. We eliminated most of those parameters that had mostly non-detects. So you can't run a PCA if you have all non-detects. The program won't run 09:16AM at all because there's no variance in the data. So we eliminated all those.

Q You eliminated what you ran through the PCA but they're still present in your environmental data; correct? 09:16AM

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Q What should this chart look like if there's a strong signature in the data?
A You have distinct groups of samples, and that's exactly what the results did when I looked at them from this particular -- 09:21AM
Q You believe, Dr. Olsen, if I understand your testimony, if I take your factor scores and I plot them in this format, I'm going to find distinct groups?
A Yes, sir, definitely. 09:22AM
Q Okay. Sir, you may or may not have seen it, but there have been some slides presented in this case discussing the diseases of Campylobacteriosis and Salmonellosis. Are you familiar with those diseases generally? 09:22AM
A Just generally.
Q You understand that's one of the health risks that the State is claiming may be present from water that receives influence from poultry litter?
A I do not know that for sure. 09:22AM
Q Sir, does your poultry signature include Campylobacter?
A No, it does not.
Q Does your poultry signature include Salmonella? 09:22AM

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A No, it does not.
Q So to understand the analysis that you've done, sir, your signature for water supposedly contaminated by poultry litter would not include either of those two elements? 09:23AM
A That's correct.
Q So under your signature, finding Campylobacter or Salmonella in the waters of the Illinois River watershed is not suggestive of contamination of poultry litter, is it? 09:23AM
A I don't think that you could make that conclusion.
Q It's not in your signature; correct?
A It's not in the signature.
Q Your signature is supposed to tell us what 09:23AM water contaminated by poultry litter would look like; correct?
A Well, what we would want to do is compare our poultry signature to where those Salmonella were found and see if the poultry signature was in that 09:23AM sample, like we did with the exceedances of bacteria.
Q Let's go back to Demonstrative Exhibit 455, State's demonstrative exhibit. It shows your list of parameters? 09:23AM

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A Yes.
Q Sir, the only bacteria in your signature for poultry litter is E. coli, fecal coliforms, Enterococcus and total coliforms; correct?
A That's correct. 09:24AM
Q You know, do you not, sir, that all four types of those bacteria are found in cattle manure?
A I don't know that for sure, but I suppose they are, yes.
Q You know, do you not, sir, that all four of 09:24AM those type of bacteria are found in human waste deposited in septic tanks?
A Probably so.
Q You know, do you not, sir, that all four of those bacteria are included in the feces of wildlife 09:24AM that live in the Illinois River watershed?
A I do not know that for sure.
Q You don't know that?
A No. I'm not a bacteria expert.
Q Dr. Olsen, does your signature allow you to 09:24AM identify -- strike that. Let me put it this way. Dr. Olsen, your signature does not allow you to identify any farm contracting with Tyson Foods, George's or any other defendant represented in this courtroom as a source of any area of water 09:24AM

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contamination in the Illinois River, does it?
A You mean does it allow me to identify a specific farm?
Q A specific farm under contract with one of the defendants. 09:25AM
A No, I've not been asked to do that.
Q Does it allow you to identify a specific defendant?
A No, I've not been asked to do that.
Q Going to Demonstrative Exhibit 461, State's 09:25AM Demonstrative Exhibit 461. Dr. Olsen, you prepared this map; correct?
A That's correct.
Q And I didn't quite follow this so I want to discuss it with you. In your direct examination 09:26AM there was some attention drawn to the green dots outside of the Illinois River watershed; do you recall that?
A Yes, sir.
Q And I think you described those as control 09:26AM areas; is that right?
A There's three green dots. There's one right above the basin that's Spring Creek, and there's two below the basin, far below the basin, not that far, kind of on the county line there that are Little Lee 09:26AM

innovation grants, modest grants of $20,000 a year to faculty and graduate students who submit proposals, investigator initiated proposals that are often difficult to obtain funding from the NIH or National Institute for Environmental Health Sciences or the CDC until a certain amount of data are collected, and then a formal proposal goes into the NIH. In the last eight years we've funded over 60 of these innovation grants, and they have ranged from documenting the emergence of antibiotic-resistant organism from the poultry and swine industry where antibiotics are used for growth promoters in subtherapeutic doses to documenting the downstream and downwind impacts of industrialized agriculture on the environments and on human populations. We've also been engaged at the policy level, and one of my staff with acting from me and involvement from me, but it was mainly her lead, coordinated a public health effort, that was a national effort last summer to try to influence the nutrition title of the farm bill, to try to improve the quality of the food available to the American people and to also through that begin to address some of the problems of our growing obesity epidemic. 09:17AM 09:17AM 09:18AM 09:18AM 09:18AM

Q Have you done research on the effect of concentrated animal feeding operations specifically on the environment?

A I have personally not directly conducted those, but members of my center have, and I have made grants to faculty colleagues who have. 09:19AM

Q Have you testified before Congress?

A Yes, I have.

Q On these issues in particular?

A Yes. In December 2005 I was invited to testify before the subcommittee of the House Energy and Commerce Committee on -- in an attempt to alter The Clean Air Act and Clean Water Act to exempt animal waste as a hazardous substance. 09:19AM

Q Dr. Lawrence, in your preparation for testimony in this case, have you had occasion to review any affidavits that have been tendered to the court by the State? 09:19AM

A Yes, I have. I've reviewed the affidavits of Dr. Teaf, Dr. Harwood, Dr. Caneday, Dr. Olsen and Dr. Fisher. 09:19AM

Q And in preparation for your testimony, have you had occasion to study any peer reviewed scientific articles relating to concentrated animal feeding operations? 09:20AM

A Yes, I have, both articles in preparation before a submission to peer review journals by members of my staff and colleagues of mine at the School of Public Health as well as articles that are published in the peer reviewed literature. 09:20AM

Q Have you in preparation for your testimony or in the capacity of your work studied any papers that focus on the effect of the Karst terrain?

A Yes. Primarily in preparation for my testimony, although concurrent and in parallel, I have been involved with the National Commission on Industrial Food, Animal Production in an effort to try to see whether or not a combination of the different geologic formations, rainfall patterns and so forth that exist across the nation might be used to improve standards for protection of groundwater and surface water. 09:20AM 09:21AM

Q And specifically have you reviewed the Karst terrain of northwest Arkansas and northeastern Oklahoma? 09:21AM

A Yes.

Q Are you familiar with the guidelines for water quality by the State Department of Public Health and Department of Environmental Quality?

A Yes, I have. I have reviewed the -- in 09:21AM

addition to the Oklahoma ones, I also have used beach closing information from the State of Connecticut.

Q And in preparation for your testimony, have you had the opportunity to review data submitted by the State from samples within the Illinois River watershed? 09:21AM

A Yes, I have.

Q And have you also in preparation for your testimony reviewed defendants' affidavits? 09:21AM

A Yes, I have reviewed the affidavits submitted by Drs. Clay, Banner, Andrews, Gibb, Jaffe, Samadpour and Dupont.

Q Specifically in regard to the affidavit of Dr. Clay, he states that land applied animal manure has been a fact since 300 BC. Have agricultural practices changed any since 300 BC? 09:22AM

A Yes, it is a fact that manure, bedding and associated animal waste has been used to fortify and modify and improve soil since antiquity, but what changed dramatically was the emergence after World War II of the industrialization of agricultural, the concentration of animal husbandry into what are now called CAFO's or concentrated animal feeding operations. The utilization of high amounts of 09:22AM 09:23AM

A That sounds right, yes.
Q You prepared an affidavit or were asked to prepare an affidavit in September?
A I met for the first time with Mr. Riggs in September and was asked to prepare an affidavit, yes. 10:23AM
Q Now, when you met with Mr. Riggs, you received a briefing by Dr. Harwood and Dr. Fisher; is that correct?
A No. Dr. Teaf and Dr. Harwood. 10:24AM
Q Teaf, and do you have any knowledge of any of the State's experts doing microbial tracking?
A Can you repeat the question?
Q Yes. Do you have any knowledge of the State or its experts doing any microbial tracking in this case? 10:24AM
A I have read the affidavits, yes, of State's experts.
Q Did you read these since you gave your deposition? 10:24AM
A I did.
Q So this is work you've done since you gave your deposition?
A I read the depositions of Drs. Teaf and Harwood since I gave my -- since I was deposed, yes. 10:25AM

Q Now, is it correct that you have not gathered any information on your own in this case? This is a yes or no question. Have you gathered any information?
MR. EDMONDSON: I object. Information is awfully broad. He just testified he read two depositions. 10:25AM
MR. RYAN: Let me clarify my question, Your Honor.
Q When I say gathered information, I'm not talking about reading other people's works. I'm talking about have you done any original work in this case? 10:25AM
A Have I gone out and sampled water?
Q That's one example of original work. There are a lot of examples. My question is, have you done anything?
A I have read EPA documents. I have read scientific papers. I have talked with colleagues. I regard that as part and parcel of gathering information, but I have not done field work directly associated with -- 10:25AM
Q Did you direct any information be obtained in this case?
A Did I direct that any -- 10:26AM

Q Yes, that any information be obtained in this case?
A I'm not sure I understand the question. I have --
Q Mr. Riggs, I need to have X, Y and Z. Would you go get that for me because I need that before I can come into court and form an opinion? 10:26AM
A No. I have talked with Mr. Teaf for clarification of some of the data that he has collected. 10:26AM
Q The question is, did you direct any information be obtained?
A No.
Q Did you see any raw data or actual data?
A I have seen what has been shown in the exhibits. 10:26AM
Q The summaries that the --
A Summary data, yes.
Q I'm asking about raw data.
A No. 10:26AM
Q You know what that means?
A I do know what that means, and I have not seen raw data.
Q Did you request you be provided with any specific information? 10:26AM

A No.
Q Were you told that you had all the information the plaintiff's lawyers had?
A I don't -- I don't recall whether I actually was told that. I know in subsequent reading of the deposition of Dr. Harwood, that I had not before my deposition had information about the work on Brevibacterium. 10:27AM
Q Did you examine any clinical or medical records in this case? 10:27AM
A No.
Q Did you identify the source of any bacteria by either consulting or microscope or anything like that?
A No. 10:27AM
Q Did you go out in the IRW in connection with your retention in this case?
A No.
Q Did you consult the CDC surveillance system for bacteria caused outbreaks? 10:27AM
A I regularly receive the bacterial surveillance reports known as MMWR by E-mail once a week. I'm one of the subscribers as most public health people are, but I've not gone beyond that to contact the CDC. 10:28AM

Q I didn't ask about contacting. I said have you consulted the CDC surveillance system to see if there's an outbreak here in the IRW?
A No.
Q Do you have any knowledge of any cluster of Salmonella or Campylobacter cases in the IRW now or at any time in the past? 10:28AM
A No.
Q Did you consult the State of Oklahoma's annual epidemiology report?
A No.
Q Now, you did look up, you said, the standards for EPA standards for primary body contact? 10:28AM
A Yes.
Q You read the deposition of Dr. Crutcher, didn't you?
A Yes.
Q Have you talked to Dr. Crutcher since you gave your deposition?
A I met him for the first time in 20 years yesterday. 10:28AM
Q Now, you gave some testimony about how Salmonella can occur from chickens. Do you recall that testimony?
A Yes.

Q What is the frequency of Salmonella in the United States?
A Oh, I don't recall a precise number. It's a significant -- it's part of the 70 to 80 million cases reported by the CDC. 10:29AM
Q I appreciate that, but I'm asking about what the frequency of Salmonella is.
A I can't give you a precise number.
Q It's related in many species, correct, not just poultry?
A That's correct.
Q Beef cattle, dairy cattle?
A Yes.
Q Swine?
A Yes. 10:29AM
Q Wildlife?
A Yes.
Q Now, you gave some testimony about what -- we just can't test for Salmonella, it's just too hard or something to that effect; correct?
A Depends on the source. It's not difficult to test for Salmonella when you have a patient with bloody diarrhea in the hospital and you take a stool sample.
Q Did you know the State spent ten million

dollars on this case?
A No.
Q Did you know they have done countless studies for Salmonella; did you know that?
A I did not know that. 10:29AM
Q Now, how many -- you talked about these edge of field samples for Salmonella. There's no EPA standard on edge of fields, is there?
A No, there is not.
Q But, nonetheless, you talked about how it exceeded EPA standards; right?
A The levels were greatly higher than what we've been talking about as EPA standards for water, yes.
Q You can't very well exceed something that doesn't exist. I mean, there's no standard to exceed for puddles and whatnot on the field?
A Uh-huh.
Q Right?
A That's correct.
Q Do you know how many times the State tested the groundwater for Salmonella?
A Well, I do have some information about -- I don't know whether you are including work done by expert witnesses on behalf of the State.
Q Yes, I am. I'm asking you about the

plaintiff's case and do you know how many times the State tested the groundwater for Salmonella?
A Well, I know there were 62 wells sampled within the Illinois River watershed. One of those wells was positive for Salmonella. 10:31AM
Q Really? Which well was that?
A I don't know.
Q Did you not testify in your deposition that there was no Salmonella whatsoever found anywhere in the IRW?
A This is information -- updated information since the time of my deposition in one of the conversations I had with Dr. Teaf.
Q Have you seen any data on this one well?
A No, but I'm mainly interested in the bacteria indicators because those are the ones that have an EPA standard. As you pointed out, there are no standards for Salmonella in surface waters, same way as no standards for edge of field.
Q I didn't point that out, but are there?
A No.
Q Okay. Now, the whole purpose of these bacteria indicators is to find pathogens; right; I mean, that's why we have them?
A Yes. 10:32AM

the line of questioning, if I went out and looked at the same number of cattle that you looked at as to whether they had trichinosis, what would it tell me about all cattle in Oklahoma, and she said nothing. There's just no way to know based on the testing 01:40PM that's been done whether this bacteria is carried by cattle, and the point as to geese and ducks was really just every bird species that she tested carried this supposedly poultry signature. We haven't tested the other thousand bird species, but 01:40PM where this so-called poultry bacteria was found in the environment, we're talking about minute amounts, talking about tiny, tiny, tiny amounts, and so the point, yes, there are way more chickens than ducks, way more turkeys than geese, but if you don't know 01:40PM whether a cow carried it, a deer carried it, I could go through the hundred animals, if you don't know and you find it in a minute amount, it's very high burden of proving to the court it came -- it substitutes for traditional fate and transport. 01:41PM That's enough I think on animals, Your Honor.

I'll end, perhaps, Your Honor, by saying, we showed the memo several times where these conclusions -- really remarkable conclusions that both of them reached, conclusions no other scientist 01:41PM

has ever been able to reach where those conclusions were stated before their work began in 2005. And I have a number of cases here that say --

THE COURT: Probably won't concede, but it is not an unreasonable working hypothesis; correct? 01:41PM

MR. JORGENSEN: I think it is, Your Honor.

THE COURT: Understanding that science is designed to test multiple working hypotheses; right?

MR. JORGENSEN: I might be willing to accept that, Your Honor, and I think you should be 01:41PM willing to accept if what you had there was we might try this, we might try this, we might try this. If you look at the memo, it said we're going to do two things. Dr. Olsen is going to develop a PCR, and that PCR is going to show a unique poultry 01:42PM signature. Never been done by anybody. Dr. Harwood is going to determine through her PCR system that there is a unique poultry bacteria. Now, either one of those, if true, would be a ground breaking break-through. They're the only two propositions 01:42PM put forward in the memo, and six million dollars later those are the exact two propositions that were offered to the court. I suggest it should offer some skepticism.

THE COURT: Well, but often science reaches 01:42PM

conclusions based upon a reasonable hypothesis; right?

MR. JORGENSEN: Perhaps.

THE COURT: That one tests?

MR. JORGENSEN: But when you have Dr. Myoda 01:42PM on the stand, perhaps we'll develop that a little further, but given the history of -- particularly like in Dr. Harwood's area of one test after another failing the idea that you say in advance, your test that uniquely fits your case. I want to bring out a 01:42PM point that Mr. Jones pointed out to me in each one of these. I hope it induces some skepticism with the court that the signatures are precisely the species that the plaintiffs need to win in this case and no other species. I mean, of the thousand or 01:43PM more species that live in this watershed, what are the odds that you would develop a signature that is unique to, in two instances, just exactly the two, turkeys and chickens, not everything else? It seems astronomical and hard to believe. 01:43PM

THE COURT: Is Mr. Page the respondent?

MR. EDMONDSON: Mr. Page will respond to the State.

THE COURT: I figured he was the scientific expert. 01:43PM

MR. PAGE: I don't know if that's a fair assumption, Your Honor, but I will respond.

THE COURT: More so than I am.

MR. PAGE: One of the first things I need to correct is this statement by the defendants that 01:43PM we did not employ a traditional fate and transport analysis. I think you'll recall that Dr. Olsen put into -- a placard up in front of you, which I was examining, talking about the pathway sampling approach. 01:44PM

THE COURT: Right.

MR. PAGE: Well, that is just the explanation of exactly what Dr. Engel told you about the amount of waste that's being released into the environment. 01:44PM

THE COURT: Otherwise, you wouldn't have focused on edge of field?

MR. PAGE: Exactly. We looked at all of the different environmental components to see if the chemicals that are associated with poultry waste are 01:44PM found in all of those downgradient locations, and they were found. They were found in all those locations. So the traditional fate and transport analysis was performed as part of the weight of evidence that several of the witnesses talked about. 01:44PM

Dr. Teaf and Dr. Olsen, that allowed them to come to the conclusion that poultry waste is being released. It contains bacteria, and it's in the recreational waters and groundwaters of the IRW. So that is something I think we need to clear up right away, 01:44PM Your Honor. Otherwise, Dr. Fisher's testimony about the Karst and where waters go and things that are in the water would make no sense and has no specific relationship to the other signatures. So I wanted to clear that up, Your Honor. 01:45PM

The other thing, as I prefaced my Daubert response to Mr. Jorgensen, is that they're saying that no other scientist has developed the poultry PCA or the poultry biomarker, but they're not saying -- and I think this is critical to Daubert. They're 01:45PM not saying that these very same techniques have been applied in an environmental context with other sources, and I think that's very, very important, Your Honor.

THE COURT: I agree. I understand. 01:45PM

MR. PAGE: That, I believe, would satisfy Daubert, and let me explain that just briefly. First of all, with Dr. Harwood's microbial source tracking, I think it's important that the court recognize, at least our recognition, that Dr. 01:46PM

Harwood is a leading expert in the field of microbial source tracking. It's the MST acronym that's used. It's the area in which PCR, the work she did laboratory independent method PCR, is one of several methods that are microbial source tracking. 01:46PM

Now, she testified to you, Your Honor, she was just recently employed by EPA to employ that method in the Gulf of Mexico, the very same method. Your Honor, one of defendants' own exhibits, it's Defendant's Exhibit 271, is an EPA guidance 01:46PM document. It's called microbial source tracking guide document. Dr. Harwood is one of the authors. She's on preface Page 4, and if the court would like to turn to Section 59, Section 0.3.2, it talks specifically about the methodology. 01:47PM

THE COURT: That's fine. I recall the document.

MR. PAGE: This particular document specifically discusses the methodology used by Dr. Harwood as a method that is commonly used published 01:47PM by EPA, USGS also, as a method for source tracking. Now, we're going to be filing a brief with you, Your Honor, that lays out some of the specific legal points, but also we wanted to give you the peer reviewed literature that talks about microbial 01:47PM

source tracking and the same method that Dr. Harwood did. It has been in peer reviewed literature. It's been published for swine, cattle, deer and other species of birds. It's the same exact methodology. We employed that methodology here in the IRW to see 01:47PM if we could identify a specific genetic piece of gene from a specific type of bird and see if it's unique, and we can find it in the environment. So it was used here for the first time in the IRW. There has not been a poultry one. If there had been 01:48PM one, we would have employed that, and so that methodology now is capable of review by the defendants. They have our samples of our -- that we ran the analysis on. They can test it, and I believe, Your Honor, it's very generally accepted 01:48PM based upon these authorities I mentioned to you. So they can test the methodology, and they have the samples, and this methodology has been employed by the EPA, the USGS and a lot of other scholars who have used it specifically in environmental context. 01:48PM I think the testimony, Your Honor, just to remind you, was also that same PCR genetic typing is the same thing that's used in criminal forensics. It's like finding the DNA at the crime scene, and also with hospital analysis for determining the sickness 01:49PM

of a patient, and those two specific applications have been approved by courts, and we'll give you those citations.

THE COURT: And I'm aware of that. Obviously that theorem has been tested numerous 01:49PM times with regard to crime scene identification. The questions in my mind are, you know, doesn't it need to be tested, that that strand of DNA is tested against other animals, organisms?

MR. PAGE: Yes, and it was done in this 01:49PM case. They took samples of human sewage, cattle, duck and geese. Now, of the only two samples where there was some cloning, where they found the same genetic sequence was one sample of duck, 1 of 20, one sample of geese, 1 in 20. So if there was a 01:50PM potential error, it may be 5 percent, but that's still a very good error rate for this type of analysis for identification.

So I would say, Your Honor, this method can be tested. It was. It was validated, as Dr. Harwood 01:50PM pointed out, and that it's generally accepted in the scientific community. In fact, acknowledged by EPA as a method, a valid method of determining the source of contamination.

THE COURT: Thank you for educating me. I 01:50PM